

AFIT/GCA/LAS/97S-2

A COST-BENEFIT ANALYSIS OF EARNED VALUE
MANAGEMENT SYSTEM CRITERIA

THESIS

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Abstract

In December 1996, the Cost/Schedule Control Systems Criteria (C/SCSC) was officially replaced by the Earned Value Management Systems (EVMS) criteria. The switch to EVMS, coupled with current acquisition reform changes, have left many wondering what the effects of these changes will be.

This thesis defines the costs and benefits of the old C/SCSC, and then compares them. Additionally, this thesis discusses the changes accompanying the switch to EVMS and the effect on the costs and benefits.

The marginal costs of C/SCSC are defined as the difference between the costs of a C/SCSC-compliant system and a contractors 'normal' management control system. The marginal system compliance costs are 334 - 481 person days, while the marginal operating costs are 50% of the C/SCSC-compliant operating costs.

Fourteen benefits of C/SCSC are detailed in this thesis. The most important benefit discovered was the data reliability that comes with a criteria-compliant management control system.

The main difference between C/SCSC and EVMS is the system certification process. Under C/SCSC, DoD teams would have to certify a contractor's system. Under EVMS, contractors have the ability to self-certify their system (with final government approval). Cost savings may result through self-certification without reductions in the benefits.

A COST-BENEFIT ANALYSIS OF EARNED VALUE MANAGEMENT SYSTEM CRITERIA

I. Introduction

General Issue

Since 1967, the Department of Defense (DOD) has required contractors to comply with Cost/Schedule Control Systems Criteria (C/SCSC) on "significant" DOD contracts. These criteria, now termed Earned Value Management System Criteria, are nothing more than standards intended to ensure that contractors use sound business practices. Reports from criteria-compliant contractors provide insight into the cost, schedule, and technical progress of the contract.

Although there have been several reports sponsored by DOD and private industry regarding either the costs or the benefits of these standards (Arthur D. Little Study and Coopers & Lybrand/TASC Study are two), we could find no study which objectively compared the cost with the benefits. It is not difficult to understand how these reports could be biased. In fact, it is easy to understand why a report sponsored by the private sector regarding the usefulness of the criteria may be biased by a desire for less government oversight. Likewise, a report sponsored by the government may be influenced by the government's legitimate need for that oversight.

We are not insinuating that any particular report is purposely incomplete or biased. However, we do suggest the undertaking of a more thorough and fair analysis that examines both the costs and the benefits of the criteria at the same time. Otherwise, a reader may be inappropriately persuaded that the costs exceed the benefits of the criteria or vice-versa.

This thesis perhaps provides the first objective comparison of the costs and benefits of the criteria. Due to shrinking defense budgets, acquisition reform, and the need to be as efficient as possible, we believe this comparison is critical for the DOD acquisition community. Many DOD sponsored studies have looked at either the costs or the benefits, but none has taken an objective look at both. In order for decision makers to be better informed when participating in future earned value streamlining decisions, an objective comparison of costs and benefits will be extremely beneficial.

Background

It is important to note that industry's 32 Earned Value Management System (EVMS) criteria replaced the DOD's 35 Cost/Schedule Control Systems Criteria (C/SCSC) in December 1996. In this thesis we use the term "criteria" to refer to either EVMS or C/SCSC criteria. We make a distinction between the two only when it is necessary. We will describe the origin and differences between the former and revised criteria later. With few exceptions, all "significant" DOD contracts must meet the criteria.

Unless waived by the Milestone Decision Authority or a designated representative, compliance with the criteria shall be required on significant contracts and subcontracts within all acquisition programs, including highly sensitive classified programs and major construction programs. This also includes significant contracts executed for foreign governments and for specialized organizations such as the Defense Advanced Research Projects Agency, and significant acquisition effort performed by Government activities. Significant contracts include research, development, test, and evaluation contracts and subcontracts with a value of \$70 million or more, or procurement contracts and subcontracts with a value of \$300 million or more (in FY 1996 constant dollars). Compliance with the criteria on contracts and subcontracts below these thresholds may be required when, in the DOD component manager's judgment, the contract risk or management interest requires assurance that the contractor's cost and schedule management control systems are acceptable. (DOD 5000.2-R, 3.3.4.3)

For contracts which must comply with the criteria, the Cost Performance Report (CPR) is also usually required. The monthly CPR summarizes the cost, schedule, and technical status of the contract, and is a key document used by government financial, contractual, and program managers. On contracts that are not significant, the Cost/Schedule Status Report (C/SSR) may be used. The C/SSR also summarizes the cost, schedule, and technical performance on the contract, but is less detailed and less reliable than the CPR.

Compliance with the criteria is usually not required on firm fixed price contracts (including firm fixed price contracts with economic price adjustment provisions), time and materials contracts, and contracts which consist mostly of level-of-effort work. Exceptions may be made by the Milestone Decision Authority (MDA) for individual contracts (DOD 5000.2-R, 3.3.4.3).

The criteria concept does not mandate a specific management control system for a contractor. Instead, the concept requires a management control system that complies with

the criteria. A contractor is free to use any management control system which meets the criteria. Since 1967, most major defense contractors have developed criteria-compliant management control systems. Although a full explanation is beyond the scope of this thesis, the criteria can be summarized into five major areas: 1) organization, 2) planning and budgeting, 3) accounting, 4) analysis, and 5) revisions and access to data.

The first area deals with organization and has five criteria which define the cost/schedule system requirements. Here, the contractor is required to use an integrated management control system to define the contractual effort with the use of a contract work breakdown structure (CWBS), and assign responsibilities for work performance (Fleming, 1992: 33-40). A key criterion under this area is the contractor's requirement to "assign responsibility for identified work to the appropriate functional area" (Gadeken, 1983: 16).

The second area of the criteria deals with planning and budgeting. Ten criteria (eleven under C/SCSC) spell out the requirements to establish and maintain a "budget" baseline for control of the work (Fleming, 1992: 41-51). All work defined in the CWBS must be scheduled, budgeted, and authorized. This leads to the "establishment of a time-phased budget baseline known as the performance measurement baseline" (Gadeken, 1983: 16).

The third area of the criteria deals with accounting requirements. In order to satisfy the six criteria (seven under C/SCSC) in this area, the contractor must satisfactorily demonstrate the ability to accumulate costs of work and materials in a manner that allows for comparison with earned value. Earned value is probably the most

important aspect of the criteria approach to program management. Instead of using the old budget versus actual method, earned value requires the quantification of a program's progress, using objective indicators of work performed. Looking at the work actually accomplished during a given period, leads way to realistic assessments of cost and schedule performance (Fleming, 1992: 53-58).

The fourth area of the criteria lists six criteria dealing with analysis. These criteria require contractors to measure the earned value, analyze cost and schedule variances, and develop reliable estimates of costs at completion (Fleming, 1992: 61-67). Specifically, these criteria detail the data that must be derived from the contractors cost/schedule control system (Gadeken, 1983: 16).

The last area of the criteria deals with revisions and data access. Five criteria (six under C/SCSC) are provided that spell out how to incorporate changes to the controlled baseline, when required, and allow appropriate government representatives to have access to the contractual data for determining criteria compliance (Fleming, 1992: 69-74).

The criteria should not be confused with earned value management. One does not require the other. Although the criteria can improve the reliability of earned value management data, the two are quite distinct. Indeed, Fleming and Koppleman advocate the use of earned value on almost any contract or project, and suggest that the criteria are necessary only on large, cost-reimbursable government contracts.

Earned value management came about because governmental buyers, before the days when C/SCSC was required, had no viable means with which to verify: 1) how much money and time a particular job would likely take, before starting it; 2) once the

work was started, what physical work was being accomplished against the money being spent; and 3) what the total cost of the project would most likely be, as well as how long completing the project would take (Fleming, 1992: 22).

In order to try and link planned events and tasks and show relationships and constraints between them, the defense community came up with PERT/CPM. PERT/CPM was used very little at first. Then the Secretary of Defense mandated that this single management technique be used on all major defense contracts (Fleming, 1992: 23).

This approach didn't work for several reasons, the most obvious being that managers despised being told exactly how to do their business. Then, in 1967, DOD officially implemented C/SCSC which defined 35 criteria or standards imposed on all significant defense contracts. This new method didn't require a specific system. It simply specified the minimum requirements which a contractor's management control system must satisfy. The two primary objectives were: 1) for contractors to use effective internal cost and schedule management control systems, and 2) for the government to have timely, auditable data for determining contract status (Fleming, 1992: 25).

C/SCSC was used for nearly thirty years, but was it effective? Arthur D. Little Incorporated performed a thorough two year study on the utility of C/SCSC. The study found that "C/SCSC-accepted systems are considered to be effective in assisting to control cost and schedule performance" (1983: IV-2). Additionally, this study found that, "C/SCSC benefits are considered to outweigh the costs. Nevertheless, most contractor program managers see a need for minor modifications to their systems. Many

government program managers agree” (1983: IV-2). It is important to note that this study did not objectively measure costs and benefits, but instead subjectively addressed the costs and benefits on the basis of respondents’ perceptions. This study validated the need for C/SCSC, but was C/SCSC the most cost effective way to implement earned value?

Initiated in a response to a request by the Deputy Secretary of Defense, the Coopers & Lybrand/TASC study undertook the task of reviewing the impact of the DOD’s acquisition regulations and oversight requirements on defense contractors. The study identified over 120 regulatory and statutory cost drivers that total 18% of value added costs (value added is equal to total costs less material costs). The study concentrated on the top ten cost drivers, of which, C/SCSC ranked third. The study concluded that, “In general, industry views the general framework and principles of cost/schedule reporting positively” (1994: 22). Industry also commented that, “. . . cost/schedule reporting is too detailed, repetitive, and voluminous to be used effectively as a management tool by either the government or industry, and that the requirement may in fact undermine program performance by diverting the time and attention of the company program manager” (1994: 22). Although this study identified total C/SCSC costs, it did not address the C/SCSC benefits. Additionally, the costs of a contractor’s normal cost/schedule control system were not compared to the incremental cost of the C/SCSC-compliant system.

A December 1994 memorandum from the director of acquisition program integration tasked all Service Acquisition Executives to begin work on a commercial

cost/schedule performance standard. In addition to movements within the DOD, industry also began changing. In 1995, Lockheed Martin created a performance management task force to “expand the use of earned value in the program management process” (Papers and Presentations, 1997: 1). The task force is to review Lockheed’s earned value management process (C/SCSC validated) and identify non-value added portions. This pioneering effort from industry was encouraged by the Under Secretary of Defense’s (Acquisition & Technology) [USD(A&T)], Dr. Kaminski (Papers and Presentations, 1997: 1).

Another evolutionary step associated with the change to EVMS was Dr. Kaminski’s December 1995 memorandum which abolished the Performance Measurement Joint Executive Group (PMJEG). The PMJEG had been chartered to ensure consistent implementation of the C/SCSC throughout the three military services (Papers and Presentations, 1997: 1). The responsibilities of the PMJEG now reside with the Defense Contract Management Command (DCMC), as the executive agent for C/SCSC (Abba, 1997: 62).

In August 1996, industry published the *Industry Standard Guidelines for Earned Value Management Systems* (GAO, 1997: 16). This guide is for the “establishment and application of an integrated management system that coordinates work scope, schedule, and cost objectives, and employ’s earned value methods for program planning and control” (*Industry Standard Guidelines for Earned Value Management Systems*, 1996: 1). The guide discusses the benefits of an earned value system and then details the guidelines.

The major difference between the C/SCSC and the EVMS is the system certification. Under the C/SCSC, a DOD team would visit the defense contractor seeking certification, and perform a review to check for compliance with the C/SCSC. The EVMS certification process can now be accomplished in two ways: either self-certification or extension of current C/SCSC certification. The self certification involves written corporate assurance that the defense contractor's program management system meets the full intentions of the guidelines. The defense contractor is responsible for the evaluation, and the certificate of compliance should be signed by the Chief Executive Officer of the company. Industry may seek the help of DOD organizations to perform or assist in these certifications, but industry controls DOD access to this process. (*Industry Standard Guidelines for Earned Value Management Systems*, 1996: Section 5).

Specific Objective

Due to downsizing, budget cuts, and acquisition reform there have been many changes in the acquisition process. The benefits of the criteria have been tested over time and much has been written, separately, about the costs or benefits of the criteria. Because we believe that little can be learned by examining either side in isolation, we will summarize the costs and benefits together. Further, we attempt to predict how the costs and benefits will be affected by the new industry guidelines for EVMS.

This research will provide a summary of the costs and benefits of C/SCSC as documented since 1967. Additionally, this research will provide a compilation of

important documents, policy memorandums, and other sources related to implementing EVMS. Research in this area has not yet been performed and will provide a single source of earned value information.

Research Questions

- 1) What are the costs of the criteria? Although it is difficult to separate the cost of using the criteria from the cost of “good business practices,” we will try to examine these costs. Clearly, without a sense of the costs required to use the standards we cannot assess the overall utility of the requirement.
- 2) What are the benefits of the criteria? An objective assessment of the benefits to both the government and contractor is also essential to determine the overall value of these standards.
- 3) How are the costs and benefits related? Based on our research we will attempt to measure the overall utility of the standards. The answer to this question is crucial and will become more important in the future. Since the military, and specifically the acquisition budgets are continually declining, many processes and requirements are being scrutinized to determine their necessity. No doubt, any non-value added activity will eventually be eliminated. If our findings justify the value of the standards, then this result may serve to help ward off any attempt to eliminate this requirement. If our research indicates that these standards are not cost effective, then perhaps we should reconsider requiring these standards.

- 4) How will the move to EVMS affect these costs and benefits? We will take a look at the new standards to try to understand how/if they will have an impact on the costs and benefits described earlier.

Description of the Remaining Research

The next chapter of this thesis will examine all known studies on the costs of the criteria. Reviews of these studies will hopefully provide a consolidated answer to the first research question. The third chapter will examine all known studies on the benefits of the criteria. Reviews of these studies will hopefully provide a consolidated answer to the second research question. The fourth chapter has two purposes. First, the costs and benefits of the criteria will be compared in an effort to answer the third research question. The second part of the fourth chapter will be a compilation of information documenting the switch from C/SCSC to EVMS criteria. This analysis will answer the last research question. Finally, we will summarize all of the research and findings in the fifth chapter.

II. The Cost of C/SCSC

Overview

What is the cost associated with implementing C/SCSC? This is a question that can not easily be answered. One must understand what is being asked before the answer can be given. A better question might be, "... what are the additional costs incurred as a consequence of using the concepts and principles embodied in the Criteria?" (Brodkorb, 1992:1). Another similar question asks what are the "... costs uniquely attributable to C/SCSC such as support of validation reviews and system description documentation?" (Gadeken, 1983: 15). For the purpose of this thesis, we want to separate the normal operating costs of a contractor's management control system from the total cost of operating a C/SCSC-compliant system (Lampkin, 1992: 3).

Before doing this, we first must address what drives C/SCSC compliance and reporting costs. The DOD's 5000.2-R (dated 15 Mar 1996), section 3.3.4.3 is the policy that directs contractors to comply with the C/SCSC:

When applicable, the contract shall require that any system used by the contractor in planning and controlling the performance of the contract shall meet the criteria set forth in Appendix VI. Nothing in these criteria is intended to affect the basis on which costs are reimbursed and progress payments made, and nothing herein shall be construed as requiring the use of any single system, or specific method of management control of evaluation of performance. The government shall not require the contractor's internal systems to be changed provided they satisfy these criteria.

Unless waived by the Milestone Decision Authority (MDA) or a designated representative, compliance with the C/SCSC shall be required on significant contracts and subcontracts within all acquisition programs, including highly sensitive classified programs and major construction programs. This also includes

significant contracts executed for foreign governments and for specialized organizations such as the Defense Advanced Research Projects Agency, and significant acquisition effort performed by Government activities. Significant contracts include research, development, test, and evaluation contracts and subcontracts with a value of \$70 million or more or procurement contracts and subcontracts with a value of \$300 million or more (in FY 1996 constant dollars). Compliance with the C/SCSC on contracts and subcontracts below these thresholds may be required when, in the DoD Component manager's judgment, the contract risk or management interest requires assurance that the contractor's cost and schedule management control systems are acceptable. On contracts that are determined to be not significant enough for C/SCSC applicability, the cost/schedule status report (C/SSR) (see 6.4.3) shall be required unless excluded in accordance with the following paragraph. Compliance with the C/SCSC shall not be required on firm fixed price contracts (including firm fixed price contracts with economic price adjustment provisions), time and materials contracts, and contracts which consist mostly of level-of-effort work. Exceptions may be made by the MDA for individual contracts.

This excerpt from the DOD regulation details when C/SCSC compliance is required. The latest amendment to Appendix VI (originally the 35 C/SCSC were listed in Appendix VI) to this regulation lists the 32 EVMS criteria with which the contractor must comply with. It is important to understand that this regulation does not allow a program manager the flexibility to determine which contracts must comply with C/SCSC, or now EVMS. However, the program manager has the power, to some extent, to control the cost reporting associated with C/SCSC or now EVMS:

The CPR DD Form 2734/1, 2734/2, 2734/3, 2734/4, and 2734/5 shall be used to obtain contract cost and schedule performance information for use in making and validating program management decisions. This report provides early indicators of contract cost and schedule problems and the effects of management action taken to resolve problems affecting cost and schedule performance.

1. CPRs shall be required on all contracts that require compliance with the Cost/Schedule Control Systems Criteria (C/SCSC) (see 3.3.4.3 and Appendix VI).

2. CPRs may be required on flexibly-priced (for example, fixed-price incentive or cost type) contracts that do not require compliance with the C/SCSC, but on which the DoD Components require more data than is available on the Cost/Schedule Status Report (see 6.4.3). Such applications shall not be used in lieu of a valid Cost/Schedule Control Systems Criteria requirement. CPR formats, level of detail, frequency, and variance analysis shall be limited to the minimum necessary for effective management control.
3. CPRs shall not be required on firm fixed price contracts unless unusual circumstances require cost and schedule visibility.
4. Data reported on the CPR shall be summarized directly from the same systems used for internal contractor management.
5. The CPR is subject to tailoring to require less data. All reporting provisions shall be negotiated and specified in the contract, including reporting frequency, variance analysis requirements, and the Contract WBS to be reported. The CPR is intended to be a primary means of communication between the contractor and the PM to report cost and schedule trends to date, and permit assessment of their likely affect on future performance on the contract. (DOD 5000.2-R, 6.4.2)

This section describes in detail when the CPR must be used. More importantly, however, is the flexibility it gives the program manager. For any given program, the CPR's formats, levels of detail, frequency, and variance analysis are determined by the program manager. The insight provided by these two sections of DOD 5000.2-R are essential in determining those costs that can be avoided by the program managers, and those costs which can only be avoided by changes in the DOD's regulations.

Now that we know what drives C/SCSC compliance and reporting costs, we can attempt to separate these costs from the normal operating costs of a contractor's management control system. In trying to do this, several difficulties arise. First, the difficulty in measuring the normal operating costs of a contractor's management control

system is almost impossible. A C/SCSC study performed by the Arthur D. Little Incorporated concluded that the normal operating costs are not available (1983: II-4). A study by Lampkin concludes that, "changes in the contractor's workload, due to the removal of the mandatory application of C/SCSC, would be insignificant. This conclusion justifies the contractor's position of giving 'nothing' back to the government for the removal of the criteria" (1992: 30). Even the recent *Earned Value Implementation Guide* acknowledges that, "The cost of implementing EVMS has defied quantification due to the difficulty in separating the incremental cost of EVMS from the normal management costs that would have been incurred in any case" (1996: 2). In fact, our literature review revealed no studies that used actual cost data to determine the normal operating costs of a contractor's management control system. The second difficulty arises from the differences in the existing management control systems between contractors. Some systems may be mature, while others are practically non-existent (Gadeken, 1983: 15). Review of all known studies on the costs of C/SCSC can not determine the normal operating costs of a contractor's management control system.

This chapter will attempt to identify and quantify the "generic" costs of a C/SCSC compliant system. From this, we can qualitatively separate those activities primarily associated with a C/SCSC-compliant system from those associated with a non-C/SCSC compliant system to determine the cost of C/SCSC. The first step in this process is breaking out the cost of a C/SCSC compliant system. Two main categories will be used: C/SCSC system compliance costs, and C/SCSC system operating costs. C/SCSC system compliance costs are those costs associated with developing and certifying a C/SCSC-

compliant management system. C/SCSC system operating costs are those costs associated with the month-to-month costs of the management system after it has been certified.

C/SCSC System Compliance Costs

Three previous studies broke down C/SCSC system compliance costs in determining the costs of C/SCSC.

Table 1. Previous C/SCSC Studies' System Compliance Cost Breakdown

(Brodkorb, 1992)	(Lampkin, 1992)	(Gadeken, 1983)
System Design Costs	Team Organization and Start-up Costs	Organization Costs
	System Assessment Costs	Planning and Budgeting Costs
	Subsystem Development Costs	Accounting Costs
System Documentation Costs	System Documentation Costs	Analysis Costs
System Implementation and Operation Costs	System Implementation Costs	Revisions and Access to Data Costs
Training Costs	System Training Costs	Validation Costs
System Evaluation Costs	Compliance and Certification Assistance Costs	
Additional Support Costs		

Defining the C/SCSC system compliance costs was an objective of the three studies. The Brodkorb and Lampkin studies broke these costs into the actual steps that take place in developing and certifying a C/SCSC system. The Gadeken study broke out

the C/SCSC system compliance costs by relating them to the five main areas of the criteria. The Brodkorb and Lampkin breakdowns are more comparable than the Gadeken.

Based on these three studies, this thesis will define C/SCSC System Compliance Costs with the following cost structure:

- C/SCSC System Compliance Costs
 - System Design Costs
 - Survey Existing Systems/Methods/Software Costs
 - Design/Integrate Subsystems Costs
 - Design reviews Costs
 - System Documentation Costs
 - System Description Costs
 - System Procedures Costs
 - Training Costs
 - Executive Training Costs
 - Intermediate Management Training Costs
 - Cost Account Manager (CAM) Training Costs
 - System Implementation Costs
 - CPR Preparation Costs
 - CA Variance Analysis Costs
 - CA Statusing Costs
 - System Evaluation Costs
 - Implementation Review Costs
 - Readiness Review Costs
 - Mock Demonstration Costs
 - Demonstration Review Costs

Figure 1. C/SCSC System Compliance Cost Structure

System design costs are those costs associated with designing a contractor's C/SCSC-compliant management reporting system. System documentation costs are those costs associated with the development and printing of the system description and procedures. Training costs are those costs associated with training CAMs, intermediate managers, and executive managers on the workings of the contractor's management

control system. System implementation costs consist of preparing cost account (CA) plans and preparing work authorization documents. Additionally, system implementation costs contain CPR preparation costs, CA variance analysis costs, and CA statusing costs for the pre-system validation duration. System evaluation costs consist of the preparation and actual system demonstration costs (Brodkorb, 1992: 10-11).

This C/SCSC system compliance cost structure is primarily based on the studies by Lampkin and Brodkorb. In the study by Lampkin, information attempting to define a generic C/SCSC implementation process was provided by C/SCSC consultants, “based on the experiences of over 25 years, working collectively with more than 750 contractors, and directly assisting 60 percent of the 240 contractors that are currently validated. . .” (1992:13). These consultants also provided the normal labor hours associated with the implementation tasks (Lampkin, 1992:13). Brodkorb identified five activities needed to validate a C/SCSC system. He attributes these activities and the associated person days to formulations resulting from Decision Planning Corporation’s 20 years of experience in assisting contractors in the development and installation of C/SCSC-compliant systems. The Brodkorb presentation assumes a generic R&D contract size of \$75M, with 80 cost accounts, 40 cost account managers, and a duration of three years (1992:6).

Based on these two studies, Table 2 identifies the person days associated with C/SCSC system compliance. The Brodkorb person days are taken from his presentation (1992: 7-13). The Lampkin person days are the arithmetic average of the low and high values presented in his study (1992: 17). The average person days are the arithmetic average of the Brodkorb and the Lampkin person days.

Table 2. C/SCSC Compliance Person Days

	Brodkorb	Lampkin	Average	% of
	Person Days	Person Days	Person Days	Person Days
C/SCSC System Compliance Costs	1,197	976	1,086	100.0%
System Design Costs	240	263	251.5	23.2%
Survey Existing System/Methods/Software Costs	20	23	21.5	2.0%
Design/Integrate Subsystems Costs	190	240	215	19.8%
Design reviews Costs	30	0	15	1.4%
System Documentation Costs	76	125.5	100.75	9.3%
System Description Costs	51	N/A	51	4.7%
System Procedures Costs	25	N/A	25	2.3%
Training Costs	213	155	184	16.9%
Executive Training Costs	4.5	N/A	4.5	0.4%
Intermediate Management Training Costs	126	N/A	126	11.6%
CAM Training Costs	82.5	N/A	82.5	7.6%
System Implementation Costs	493	240	366.5	33.7%
CPR Preparation Costs	374	N/A	N/A	N/A
CA Variance Analysis Costs	59	N/A	N/A	N/A
CA Statusing Costs	60	N/A	N/A	N/A
System Evaluation Costs	175	192	183.5	16.9%
Implementation Review Costs	8	14	11	1.0%
Readiness Review Costs	35	42.5	38.75	3.6%
Mock Demonstration Costs	63	49	56	5.2%
Demonstration Review Costs	69	86.5	77.75	7.2%

Table 2 allows us to quantify the C/SCSC compliance work load into person days. Rates are not being applied to these person-days, but rather percentages are being used to make these values usable among different burdened labor rates. Table 2 shows that the majority, 56.9% (23.2% + 33.7%), of the C/SCSC system compliance costs are spent on system design and system implementation costs. The Lampkin study also attempted to quantify these C/SCSC system compliance costs as a percentage of the total contract

value. The study cited five previous studies, all based on subjective assessments of costs from government and industry experts, that had looked at the C/SCSC system compliance costs. One of the previous studies, by Humphreys and Associates, broke the cost percentages into two categories: recurring and non-recurring. The recurring costs are those C/SCSC system compliance costs related to a previously validated system. The non-recurring costs are those C/SCSC system compliance costs associated with a contractor going through the validation process for the first time (Incidentally, the C/SCSC system compliance person days shown in Table 2 are of the non-recurring type). Lampkin also stated that this was the only previous study to differentiate between the two types of costs (1992: 34-37). Table 3 summarizes Lampkin's conclusions:

Table 3. C/SCSC System Compliance Costs (% of Total Contract Value)

Study (Year)	Cost Range	Basis	Recurring	Non-Recurring
MITRE	0.1 - 0.2%	Software Acq Model	N/A	N/A
SPARROW	0.6 - 1.0%	Cost Est. Model	N/A	N/A
KOUTS	0.5 - 5.0%*	Industry Response	N/A	N/A
DoD IG	5.0%	DoD Response	N/A	N/A
HUMPHREYS	0.5% - 4.0%	Consultant Response	0.5% - 1.5%	2.5% - 4.0%
Lampkin Avg Range	0.4% - 2.86%		0.4%	1.63%
Lampkin Mean of Averages	1.69%		N/A	N/A

*Note: 3% is the average.

Table 3 provides a summary of past C/SCSC system compliance cost studies. However, no assumptions or details about these studies are given, thus the credibility of these findings is somewhat questionable.

The final consideration in the C/SCSC system compliance costs is the government costs. The government will incur costs both for personnel assigned to review a contractor's management control system and for travel.

C/SCSC System Operating Costs

Unlike C/SCSC system compliance costs, C/SCSC system operating costs are extremely dependent on the program manager's contractual cost reporting requirements. The program manager controls the frequency, WBS level and format of the cost reporting, and the detail and thresholds of variance analysis required. These factors can cause wide fluctuations in the C/SCSC system operating costs.

Based on the 1992 Brodkorb presentation, the following relationship equations will be used to estimate the cost of the C/SCSC system operating costs.

Table 4. C/SCSC System Operating Hours

Activity	Estimating Relationship Equations
CPR Preparation Hours	# of Post Validation CPRs cycles * 40 hrs/CPR
CA Variance Analysis Hours	# of Post Validation CPR cycles * (1/3) * # of CAs * 3hrs/CA
CA Plan Statusing Hours	# of Post Validation CPR cycles * # of CAs * 1hr/CA
Total C/SCSC System Operating Hours	$[40 + (2 * \# \text{ of CAs})] * (\# \text{ of Post Validation CPR cycles})$

To illustrate this, let's assume a 3 year contract, with 80 cost accounts, monthly CPR reporting, and a validation duration of 9 months. The preparation of the CPR for the remaining 27 months takes 1,080 hours ($27 * 40$), or 135 person days ($1,080 / 8$). The

CA variance analysis takes 2,160 hours ($27 * 1/3 * 80 * 3$), or 270 person days ($2,160 / 8$). The CA plan statusing also takes 2,160 hours ($27 * 80 * 1$), or 270 person days ($2,160 / 8$). From this, the total C/SCSC system operating hours are 5,400 ($1,080 + 2,160 + 2,160$), or 675 person days ($5,400 / 8$).

In addition to the contractor's costs, the government also has C/SCSC system operating costs. Government person hours are used to analyze CPRs, prepare EACs, and implement baseline changes.

Conclusion

This chapter began by attempting "... to separate the normal operating costs of a contractor's management control system from the total cost of operating a C/SCSC compliant system (Lampkin, 1992: 3). We have identified the total costs of operating a C/SCSC compliant system, and will now qualitatively separate the 'normal' operating costs.

C/SCSC compliance costs were separated into five categories: 1) system design costs, 2) system documentation costs, 3) training costs, 4) system implementation costs, and 5) system evaluation costs. System design costs are necessary for both the C/SCSC compliant systems as well as the 'normal' systems. It is very obvious that a commercial management control system must first be designed before it can be used.

System documentation costs are not clearly a needed product of a 'normal' system. Added to this are the 32 criteria (35 under C/SCSC) which the system must

meet. In a 1992 study by Lampkin, six out of eight contractors had to develop system descriptions to comply with C/SCSC. Also, it was determined that fifty percent of these costs are 'CS only' costs. Additionally, all eight contractors responded that they had to expand their written procedures to comply with C/SCSC. With this in mind, it is a reasonable assessment that the system documentation for a 'normal' system would be half that of a C/SCSC compliant system.

System training costs are clearly needed for both a 'normal' and a C/SCSC-compliant management control system. A contractor needs to train the users of their system whether it is C/SCSC compliant or not.

System implementation costs are those operating costs incurred before the contractor's system is validated. In essence, they are a means for testing the management control system. This would have to be done with a 'normal' system, however, the amount of reporting and variance analysis performed as a result of C/SCSC has been excessive in the past. The 1992 study by Lampkin found that system implementation activities such as performance reporting procedure needed to be developed by the majority of the contractors surveyed. The 'CS only' costs ranged from 30% to 70%. This reporting and variance analysis can be reduced by the government program manager, however, we conclude that the 'normal' system implementation costs will range from 30% to 70% of C/SCSC-compliant system implementation costs.

Finally, it is understood that the majority of system evaluation costs are only associated with C/SCSC-compliant systems. In the 1992 study by Lampkin, 95% of the system evaluation costs were defined as 'CS only' costs. Henceforth, 'normal' system

evaluation costs are estimated as 5% of C/SCSC-compliant system implementation costs.

The above analysis leads us to conclude the following:

Table 5. Marginal C/SCSC Compliance Costs

	C/SCS Compliant Costs	'Normal' System Compliance Costs	Marginal Cost of C/SCSC Compliance
	Person Days	Person Days	Person Days
System Compliance Costs	1,086	605-752	334-481
System Design Costs	251.5	251.5	0
System Documentation Costs	100.75	50.38	50.38
Training Costs	184	184	0
System Implementation Costs	366.5	109.95-256.55	109.95-256.55
System Evaluation Costs	183.5	9.18	174.32

From this table, we conclude that the marginal C/SCSC compliance costs are 31-44% (Marginal Cost divided by C/SCSC-compliant costs) of the total C/SCSC compliance costs.

As acquisition reform continues to model government practices after commercial practices, the difference between a C/SCSC-compliant system and a 'normal' system will hopefully decrease. Changes in C/SCSC reporting requirements and system acceptance procedures can decrease the marginal cost.

'Normal' system operating costs are concluded as 50% of C/SCSC. The 1992 study by Lampkin determined that fifty percent of these operating costs are 'CS only.' It is evident that there are excessive reporting requirements, "... all contractors subject to C/SCSC agree that, as currently required by the DoD, cost/schedule reporting is too

detailed, repetitive, and voluminous to be used effectively as a management tool by either the government or industry, . . .” (Coopers & Lybrand and TASC, 1994: 22). One initiative to decrease criteria-compliant system operating costs is summary level variance analysis. This initiative combines cost accounts in an effort to reduce the volume of variance analysis and was tested at some defense contractors. IBM Federal Systems cites a 45% reduction in variance analysis volume attributed to summary level variance analysis. McDonnell Douglas Aerospace claims a 20%-40% cost reduction due to summary level variance analysis (Pakiz, 1993: 1-7). These cost savings realized from this commercial practice are just an example of the marginal system operating costs that can be reduced.

It is important to compare these conclusions to the findings of the 1994 Coopers & Lybrand/TASC report. This report concluded that DOD regulatory compliance costs are 18% of the ‘value added’ costs (47). ‘Value added’ costs are defined as total contractor costs less material costs, and are approximately 60% of total costs (4). This report also concluded that C/SCSC regulatory requirements account for 0.9% of the total ‘value added’ cost (18). For example, on a \$100M contract, \$60M are identified as ‘value added’ costs. Of this \$60M, 18% (\$10.8M) are a result of regulatory compliance. The C/SCSC compliance costs in this example would be 0.9% of \$60M or \$0.54M. This cost represents 0.54% of the total contract value (\$100M) and is consistent with the findings in Table 3. While the C/SCSC regulatory compliance costs do not seem very high, it ranked third in the report’s top ten cost drivers. This report drove the need for the

establishment of the “ . . . Regulatory Cost Premium Working Group to coordinate DOD-wide efforts to address cost drivers” (GAO, 1996: 2).

With all of the attention concentrating on the costs of C/SCSC regulatory compliance, the benefits of compliance were not addressed. Coopers & Lybrand/TASC stated that, “. . . some claim that DOD receives substantial benefits from its regulatory activities. The Project Team did not attempt to validate the existence of such benefits or quantify their value. In other words, we looked only at the ‘cost’ portion of the cost/benefit ratio” (1994: 3). The GAO report addressing the Coopers & Lybrand/TASC report, and the results from the Regulatory Cost Premium Working Group stated that, “. . . savings resulting from current DOD initiatives may be significantly less than the 18-percent cost premium identified by Coopers and Lybrand” (1996: 3). The GAO report then addresses why the actual savings are significantly less,

One explanation for the disparity between Coopers and Lybrand’s 18-percent cost premium and the reinvention laboratory results is that Coopers and Lybrand did not attempt to assess the benefits resulting from the cost drivers it identified. Rather, the Coopers and Lybrand study analyzed only the cost impact of DOD’s regulations and oversight requirements on contractors. DOD’s Reducing Oversight Costs Reinvention Laboratory identified a significantly lower cost savings potential because some of the cost drivers made good business sense. In addition, contractors would have similar self-imposed requirements in the absence of some of DOD’s regulatory requirements. (1996: 5)

To make a decision on the need for C/SCSC, it is essential to look at both the costs and benefits. This chapter detailed the costs, while Chapter III will outline and discuss the benefits of C/SCSC.

III. Benefits of C/SCSC

Overview

What are the benefits that result from using a C/SCSC compliant system? During our research we found much literature on the subject that lends general, as well as very specific, support for the criteria (GAO, 1997; Coopers & Lybrand and TASC, 1994; DoD/NSIA, 1991; Little, 1984; Little, 1983; NSIA, 1980). We will examine these studies, and other literature, related to the benefits of C/SCSC (or EVMS) in more detail later in this chapter. But first, we will review the actual criteria as spelled out in Appendix VI of DoD 5000.2-R. Next, we will explain how earned value fits into the picture. Finally, we will show how the criteria may result in many benefits to the DoD and to government contractors.

The Specific Criteria

Most of the material we draw upon in this chapter is related specifically to C/SCSC. Therefore, we will address the benefits of C/SCSC first. Later on, we will point out the differences between the new EVMS criteria and the former C/SCSC criteria they replaced. Then, we will describe how the new criteria affect these same costs and benefits that we present in this paper. Table 6 provides a list of the 35 C/SCSC criteria.

Table 6. C/SCSC Criteria (DoD 5000.2-R Appendix VI)

Organization	
1.	Define all authorized work and related resources to meet the requirements of the contract, using the framework of the contract work breakdown structure.
2.	Identify the internal organizational elements and the major subcontractors responsible for accomplishing the authorized work.
3.	Provide for the integration of the contractor's planning, scheduling, budgeting, work authorization, and cost accumulation systems with each other, the contract work breakdown structure, and the organizational structure.
4.	Identify the managerial positions responsible for controlling overhead (indirect costs).
5.	Provide for integration of the contract work breakdown structure with the contractor's functional organizational structure in a manner that permits cost and schedule performance measurement for contract work breakdown structure and organizational elements.
Planning & budgeting	
6.	Schedule the authorized work in a manner that describes the sequence of work and identifies the significant task interdependencies required to meet the development, production, and delivery requirements of the contract.
7.	Identify physical products, milestones, technical performance goals, or other indicators that will be used to measure output.
8.	Establish and maintain a time-phased budget baseline at the cost account level against which contract performance can be measured. Initial budgets established for this purpose will be based on the negotiated target cost. Any other amount used for performance measurement purposes must be formally recognized by both the contractor and the government.
9.	Establish budgets for all authorized work with separate identification of cost elements (labor, material, etc.).
10.	To the extent the authorized work can be identified in discrete, short- span work packages, establish budgets for this work in terms of dollars, hours, or other measurable units. Where the entire cost account cannot be subdivided into detailed work packages, identify the far-term effort in larger planning packages for budget and scheduling purposes.
11.	Provide that the sum of all work package budgets plus planning packages within a cost account equals the cost account budget.
12.	Identify relationships of budgets or standards in underlying work authorization systems to budgets for work packages.
13.	Identify and control level of effort activity by time-phased budgets established for this purpose. Only that effort which cannot be identified as discrete or as apportioned effort will be classed as level of effort.

14.	Establish overhead budgets for the total costs of each significant organizational component whose expenses will become indirect costs. Reflect in the contract budgets, at the appropriate level, the amounts in overhead pools that will be allocated to the contract as indirect costs.
15.	Identify management reserves and undistributed budget.
16.	Provide that the contract target cost plus the estimated cost of authorized but unpriced work is reconciled with the sum of all internal contract budgets and management reserves.
Accounting	
17.	Record direct costs on an applied or other acceptable basis in a formal system that is controlled by the general books of account.
18.	Summarize direct costs from cost accounts into the work breakdown structure without allocation of a single cost account to two or more work breakdown structure elements.
19.	Summarize direct costs from the cost accounts into the contractor's functional organizational elements without allocation of a single cost account to two or more organizational elements.
20.	Record all indirect costs that will be allocated to the contract.
21.	Identify the basis for allocating the cost of apportioned effort.
22.	Identify unit costs, equivalent unit costs, or lot costs, as applicable.
23.	The contractor's material accounting system will provide for: a. Accurate cost accumulation and assignment of costs to cost accounts in a manner consistent with the budgets using recognized, acceptable costing techniques.
b.	Determination of price variances by comparing planned vs actual commitments.
c.	Cost performance measurement at the point in time most suitable for the category of material involved, but no earlier than the time of actual receipt of material.
d.	Determination of cost variances attributable to the excess usage of material.
e.	Determination of unit or lot costs when applicable.
f.	Full accountability for all material purchased for the contract, including the residual inventory.
Analysis	
24.	Identify at the cost account level on a monthly basis using data from, or reconcilable with, the accounting system: <ul style="list-style-type: none"> a. Budgeted cost of work scheduled and budgeted cost of work performed. b. Budgeted cost of work performed and applied (actual where appropriate) direct costs for the same work.
	c. Variances resulting from the above comparisons classified in terms of labor, material, or other appropriate elements together with the reasons for significant variances.

25.	Identify on a monthly basis, in detail needed by management for effective control, budgeted indirect costs, actual indirect costs, and variances along with the reasons.
26.	Summarize the data elements and associated variances listed in [24] and [25] above, through the contractor organization and work breakdown structure to the reporting level specified in the contract.
27.	Identify significant differences on a monthly basis between planned and actual schedule accomplishment and the reasons.
28.	Identify managerial actions taken as a result of criteria items [24] through [27] above.
29.	Based on performance to date, on commitment values for material, and on estimates of future conditions, develop revised estimates of cost at completion for work breakdown structure elements identified in the contract and compare these with the contract budget base and the latest statement of funds requirements reported to the government.
Revisions and access to data	
30.	Incorporate contractual changes in a timely manner, recording the effects of such changes in budgets and schedules. In the directed effort before negotiation of a change, base such revisions on the amount estimated and budgeted to the functional organization.
31.	Reconcile original budgets for those elements of the work breakdown structure identified as priced line items in the contract, and for those elements at the lowest level of the DOD program work breakdown structure, with current performance measurement
32.	Prohibit retroactive changes to records pertaining to work performed that will change previously reported amounts for direct costs, indirect costs, or budgets, except for correction of errors and routine accounting adjustments.
33.	Prevent revisions to the contract budget base except for government- directed changes to contractual effort.
34.	Document internally, changes to the performance measurement baseline and notify the procuring activity expeditiously through prescribed procedures.
35.	Provide the contracting officer and the contracting officer's authorized representatives with access to the information and supporting documents necessary to demonstrate compliance with the cost/schedule control system criteria.

Criteria Benefits versus Earned Value Benefits

Before delving into the details of the benefits we should make a distinction between earned value benefits and benefits of the criteria. But first, we will briefly review the concept of earned value.

Earned value is a management technique that relates resource planning to schedules and to technical performance requirements. Without earned value, one can only compare how much has been spent with what was planned to be spent ("spend plan" management), with no objective indication of how much of the planned work actually was accomplished for those dollars spent. Cost/Schedule Control Systems Criteria (C/SCSC) require the contractor to plan, budget, and schedule all authorized effort in time-phased "planned value" increments constituting a "performance measurement baseline." As work is accomplished, it is "earned" on the same basis it was planned, in dollars or other measurable units, such as labor hours. Planned value compared with earned value thus measures the dollar volume of work planned versus the equivalent dollar volume of work accomplished. (Deskbook, 2.B.2.1)

A C/SCSC compliant system has the ability to produce the data needed to perform earned value analyses. Our research indicates many benefits can be obtained through the use of earned value analysis techniques. However, earned value techniques are only a subset of the benefits related to C/SCSC. Indeed, there are many other benefits resulting from the use of the criteria but unrelated to earned value analysis techniques. Clearly, earned value analysis can be performed without being required by the criteria. However, in the absence of certain criteria, many of these benefits may be less achievable. Without the discipline required by the criteria, how can we ensure the data is accurate? Without accurate data, how valid will the earned value analyses be? Thus, we assert that any

benefits derived through earned value techniques are ultimately benefits attributable to the criteria.

Ten Benefits of Earned Value

Fleming and Koppelman recently published a book regarding earned value with one chapter explicitly describing the benefits of C/SCSC (Fleming and Koppelman, 1996: 21-29). In this chapter, they provide a list of ten of the most important contributions resulting from the employment of C/SCSC. This list is based on their review of the existing body of knowledge on the subject and is summarized in Table 7 below.

Table 7. Fleming and Koppelman's Benefits of C/SCSC

1.	Employment of a single management control system which provides accurate, consistent, reliable, and timely data for use by all levels of management.
2.	A management approach that integrates cost, schedule and technical parameters allowing for the continuous measurement of integrated performance.
3.	Documented empirical database collected from [thousands] of DoD contracts reflecting a consistent and predictable performance history.
4.	Utility and stability of the cumulative Cost Performance Index (CPI_{CUM}) to continuously monitor performance trends of a project.
5.	Utility of the Schedule Performance Index (SPI) to monitor and quantify the value of the work scheduled and to compare it against work performed.
6.	Utility of the CPI_{CUM} to statistically forecast low end range of completion costs.
7.	Utility of the CPI_{CUM} combined with SPI to forecast most likely completion cost.
8.	Utility of the To-Complete Performance Index (TCPI) to monitor remaining tasks against a specific management financial goal.
9.	Utility of a weekly (or periodic) CPI to measure actual performance against a pre-set standard.
10.	The use of Management by Exception principles to focus management's attention on significant exceptions to the authorized plan.

These ten areas will serve as the major backbone of this chapter regarding the benefits of C/SCSC. The rest of the chapter will expound upon Fleming and Koppelman's work by linking it with other literature related to benefits of the criteria.

The Ten Benefits Described

Benefit One. The first benefit highlighted by Fleming and Koppelman is derived from the employment of a single management control system. In the past, many problems resulted from contractors managing with one system and reporting from another. The first five criteria under C/SCSC or EVMS deal with organization and are closely related to this benefit. These criteria permit only one work breakdown structure per contract. Therefore, contractors are forced to manage and report from the same system. The motivation to require a singular system came about because the contractor's

... project manager, senior corporate management, chief financial officer, and others, often had their own data, which frequently did not match other data. Obviously, this condition produced disastrous performance results ... a single management control system provides accurate, consistent, reliable, and timely data that management at all levels can use to monitor performance throughout the life cycle of a project. (Fleming and Koppelman, 1996: 22)

Although the new EVMS criteria do not specify the exact format of the work breakdown structure, the requirement for the contractor to develop a WBS is listed in section 4.4.2 of DoD 5000.2-R. Therefore, there is very little difference between the five new EVMS organizational criteria and the old C/SCSC organizational criteria. Under

EVMS, the contractor is still required to perform the same basic steps as before under the C/SCSC organizational criteria. The contractor is still required to: define the authorized work elements for the program; identify the program organizational structure; define the organizational elements in which work will be planned and controlled; provide for the integration of the company's planning, scheduling, budgeting, work authorization, and cost accumulation processes with each other; identify the company organization or function responsible for controlling overhead; and provide for integration of the program work breakdown structure and the program organizational structure in a manner that permits cost and schedule performance measurement by elements of either or both structures as needed.

In the Preface to the C/SCSC White Paper, Abba explains that "C/SCSC provide the best tool available to assure contractors have and use adequate cost and schedule management control systems... a C/SCSC compliant system can ensure that valid cost and schedule performance data are generated, easing the manager's task in making the correct decision" (1986: viii).

In the past, contractors were required to prove to the government that their management control systems were in compliance with C/SCSC requirements through a formal validation process. Presutti, regarding a validated system, states "this approval gives any user some confidence in the information that the system can provide" (1993: 53). Not only will reliable data foster good decision making; greater confidence in that data can multiply the effect. In other words, managers should be able to make better decisions if they have more confidence in the information provided by their system.

Benefit Two. Another benefit gained through the use of C/SCSC is “a management approach that integrates the technical scope of work, the schedules, and the costs, allowing for the continuous measurement of integrated performance throughout the life cycle of the project or a production effort” (Fleming and Koppelman, 1996: 23). The third criterion, under both C/SCSC and EVMS, requires the contractor to integrate their planning, scheduling, budgeting, work authorization and cost accumulation systems with each other.

Instead of projects being defined and measured by parochial interests in a non-integrated manner as was frequently the case in the past, now performance measurement could take place in a much more highly integrated manner (Fleming and Koppelman, 1996: 23). This new integrated approach served to help various functional personnel to “speak a common project language for the first time” and allowed the various functional metrics to be much easier to relate to each other (Fleming and Koppelman, 1996: 23).

Responses to the National Security Industrial Association (NSIA) survey show that when asked what measurements are visible in their labor work package system beside budget, the respondents indicated that earned value is used more than any other measurement listed, including “underlying standards/goals [of the organization]” (NSIA, 1980: III-15). The purpose of the NSIA study was to provide industry with a data base to aid contractors recently exposed to Performance Measurement System Requirements as well as contractors with previously accepted systems. Another objective of this project was to provide data from which future improvements could be made in requirements and implementation practices. Seventy-four companies responded to this questionnaire.

Benefit Three. Another benefit resulting from the use of C/SCSC is the documented empirical data compiled over the years from thousands of DOD contracts. The first criterion, under C/SCSC and EVMS, requires contractors to define the authorized work elements. Under C/SCSC, this criterion requires preparation of a work breakdown structure consistent with governmental guidelines. Development of a WBS in this manner allows the government to be able to compare that program with others in its historical database (Fleming, 1992: 79). Under EVMS, however, the requirement for a WBS is not specifically stated. Instead, the WBS requirement is provided in DoD 5000.2-R with guidelines for its development found in MIL-HDBK-881.

The analysis of contracts employing earned value has provided some important insights about government contracts. After a project is about 20% complete, history has shown there is very little chance that any overruns can be recovered, and will usually worsen (Christensen, 1993: 15). Even with this knowledge, it is still very beneficial to be able to predict, with some degree of confidence, the final cost and schedule early in a project.

The A-12 acquisition program highlights the benefits of having such a database. In an interview with David Christensen, Ph.D., he stated “because we had a reliable, comprehensive record of performance on other, similar projects, we could better evaluate the progress on the A-12 program” (Christensen, 1997). Figure 2 depicts how the performance of the A-12 compared with other programs (Abba, 1991: 13).

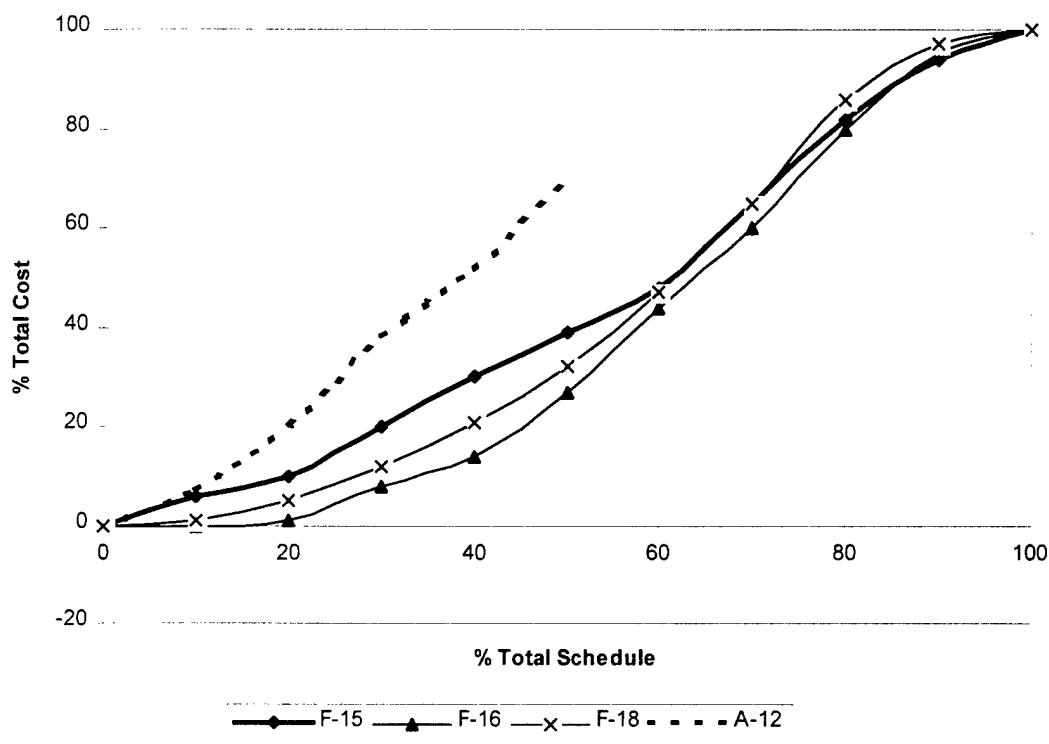


Figure 2. A-12 Performance Comparison

Christensen stated that this graph was presented to Secretary of Defense, Richard Cheney, and was regarded as compelling evidence that the A-12 program was out of control (Christensen, 1997).

Benefit Four. Another major benefit gleaned from the use of C/SCSC stems from the utility and the stability of the cumulative Cost Performance Index (CPI_{CUM}). The seven accounting criteria (six under EVMS) establish the foundation for this benefit. These criteria do not require a specific accounting system, but they do require proper interfaces be established between the accounting system and the performance measurement system. This “ensures compatibility of actual costs and budgeted costs in the performance

reports” (Presutti, 1993: 52). Of course, this compatibility is fundamental to valid and accurate earned value analyses.

Again, using cumulative contract performance data, management is able to assess the performance to date and to predict the final performance results quite well at a very early point. In fact, “based on data from the Defense Acquisition Executive Summary database, results indicate that the cumulative CPI is stable from the 20 percent completion point regardless of contract type, program, or service” (Christensen and Heise, 1993: 7).

Benefit Five. Another area of benefit regarding C/SCSC is gained through the use of the Schedule Performance Index (SPI). The SPI can be used to monitor and quantify the value of the work scheduled and to compare it against the value of work physically performed. Criteria 6, 7 and 27, under C/SCSC (criteria 6, 7, and 25 under EVMS), deal with the need to have a formal scheduling process. Regarding these criteria, Fleming and Koppelman ask the rhetorical question: “are these three criteria unique to an earned value approach?” Their response is: “Absolutely not. These three criteria lay down fundamental scheduling principles which would apply to any project anywhere in the world” (1996: 48).

Contractors in compliance with C/SCSC can easily compute this index which allows a quick determination of how far ahead or behind the planned schedule they are. The SPI can be used in conjunction with the Critical Path Method (CPM) to help manage the project schedule more effectively.

Benefit Six. Another benefit of C/SCSC is related to the utility of the cumulative Cost Performance Index (CPI_{CUM}). Criterion 29, under C/SCSC (criterion 27 under EVMS), requires the contractor to develop a revised estimate of the contract completion costs. Once compliance with the other criteria has been established, the data needed to calculate this index is readily available. Although contractors are not specifically required to utilize the CPI_{CUM} index, it definitely has merit. According to Christensen and Heise, “because the cumulative CPI tends to decline, the EAC computed by the cumulative CPI is a reasonable floor for the final cost at completion” (1993: 13). In a later study, Christensen provides strong evidence that the “CPI-based EAC is a reasonable lower bound to the final cost of a defense contract” (Christensen, 1996: 46). This study was performed using data from sixty-four completed defense contracts.

A good example of this benefit can be found within the Defense Contract Audit Agency (DCAA). When the government cancels a contract for its own convenience, it must ensure that the Estimate at Completion (EAC) is accurate. If it is accurate, the EAC becomes the basis for termination costs. In today’s environment of shrinking defense budgets, the DCAA may be involved in more and more contract terminations for government convenience (Presutti, 1993: 53). Accurate estimates can undoubtedly save the government substantial amounts of money in termination costs.

According to phase one of the Arthur D. Little study,

more than half of the government business managers surveyed gave favorable ratings to the reports for estimates-at-completion, cost impacts of known problems, problem traceability, and schedule status. Further, more than half the contractor program managers rated the reports

favorably with respect to EAC and cost impacts of known problems. (1983: III-5)

Benefit Seven. The utility of the CPI_{CUM} combined with the SPI to statistically forecast the “most likely” range of estimated costs at completion is yet another benefit of C/SCSC. Again, the first three sections of the criteria make it possible to perform the earned value analyses that are required in the analysis section. Although contractors are not required to use this “combined” method to develop an estimated cost at completion, they might want to consider this method. In fact, many government managers utilize this method for calculating estimates of completion costs. According to Fleming and Koppelman, combining both indexes allows us to account for the compounding effects of performance that is both behind schedule and over cost (1996: 27). The ability to predict most likely contract completion costs are useful for budgetary purposes, or in determining if a project should be terminated in favor of less problematic programs. Defense projects are continuously battling for limited funds, and those encountering major problems are often canceled prematurely.

Benefit Eight. Benefits can also be obtained through the use of the To-Complete Performance Index (TCPI) to monitor the remaining project tasks against a specific management financial goal. Basically, this index is calculated by dividing the remaining work by the remaining budget (or a revised budgetary goal). Criterion 24, under C/SCSC (criterion 22 under EVMS), requires the contractor to identify the budgeted cost of work scheduled (BCWS), the budgeted cost of work performed (BCWP), and the actual cost of work performed (ACWP) on a monthly basis. After fulfilling this requirement, the

contractor, or the government, has the data necessary to calculate the TCPI. This index reflects how efficient the contractor's remaining performance must be to recover from a negative position. Christensen and Heise state "when the TCPI is significantly greater than the cumulative CPI and the contract is beyond the 20 percent completion point, it is likely that the contract will overrun the budgetary goal despite any optimistic claims to the contrary" (1993: 15). Of course, without the other criteria, the validity of this index would be questionable.

Benefit Nine. Another benefit of C/SCSC relates to the utility of a periodic CPI based on the actual performance it took to achieve a particular planned production standard. Again, C/SCSC and EVMS require the contractor to identify the BCWS, BCWP, and ACWP on a monthly basis according to C/SCSC criterion 24 (EVMS criterion 22). After fulfilling this requirement, the contractor, or the government, has the data necessary to measure the periods' performance against a predetermined standard. Of course, without the other criteria (related to organization, planning and budgeting and accounting), the comparison would most likely be faulty.

Benefit Ten. The last benefit listed by Fleming and Koppelman is related to Management by Exception (MBE) principles that are an inherent part of a valid earned value management control system. A contractor that has complied with the first three sections of criteria related to organization, planning and budgeting, and accounting, is now well suited to determine the status of their efforts. In fact, the analysis criteria require the contractor to perform analysis and explain what is being done to correct problems. However, instead of requiring the contractor to explain every minute

deviation. "Earned value project management allows the project manager and busy corporate executives to utilize the [MBE] principle to the fullest" (Fleming and Koppelman, 1996: 88). Management's attention can be triggered by exceptions to the authorized plan without them having to continuously monitor the smallest details of the program.

Criteria in the last section of C/SCSC and EVMS related to revisions and access to data are very important as well. Virtually all major projects will encounter changes to the original baseline. In order to comply with the criteria, the contractor must "accommodate such changes in an orderly and controlled and documented manner, consistent with its written procedures" (Fleming, 1992: 69). This ensures a proper audit trail is available between newly authorized work and the original performance baseline. It also helps ensure the validity of the data provided by the contractor. Therefore, these criteria are related to all ten of the benefits listed above.

Other Benefits

There are other benefits of the criteria that may not appear to relate specifically, although they may be linked ultimately, to the ten benefits laid out by Fleming and Koppelman. For instance, in order to comply with the criteria, contractors may be forced to do some things better up front that they might not have done otherwise. In fact, results from phase two of the Arthur D. Little study indicate

a large majority of contractor program managers (74%) and government business managers (77%) also believe a major benefit of

C/SCSC is more thorough contractor planning than otherwise would be accomplished. (1984: III-2)

Government review teams can also provide benefits to contractors. Review teams can be of benefit “by drawing on their previous experience to suggest good features of other systems to improve weak features of a contractor’s systems” (Whittenberg, 1972: 78).

Other Evidence of Benefits

According to a study performed by the Arthur D. Little Program Systems Management Company,

the most important overall conclusion of the study is that C/SCSC is a valid concept and approach to controlling contract performance. (1984: I-3)

This study was conducted in an effort to resolve two controversies surrounding C/SCSC:

1) do the costs of the criteria and associated reporting requirements outweigh their benefits?, and 2) concerns about the specifics of how these requirements have been implemented (Little, 1983: I-1). The study was accomplished in two phases: the first phase involved a mailed questionnaire, and the second involved in-depth interviews with DoD and industry respondents.

A joint DOD and NSIA report identified opportunities to improve the cost and schedule management process. The report stated “Conclusions clearly indicate that both DoD and industry place high importance on the need for cost/schedule management control systems. They also agree that change is necessary to improve the quality and

efficiency of cost/schedule performance measurement and reporting” (1991: 1-1).

Additionally, the report found that, “More than 90 percent of all interviewees (DoD and industry) place extremely high importance on the need for standard cost/schedule management systems criteria as defined by DoDI 7000.2” (1991: 1-5).

A 1994 study requested by the Deputy Secretary of Defense and conducted by a joint Coopers & Lybrand and TASC project team looked at the impact of DOD regulations and oversight. C/SCSC was one of the regulatory areas identified by the study as having a low added value. However, the report states, “in general, industry views the general framework and principles of cost/schedule reporting positively” (1994:22).

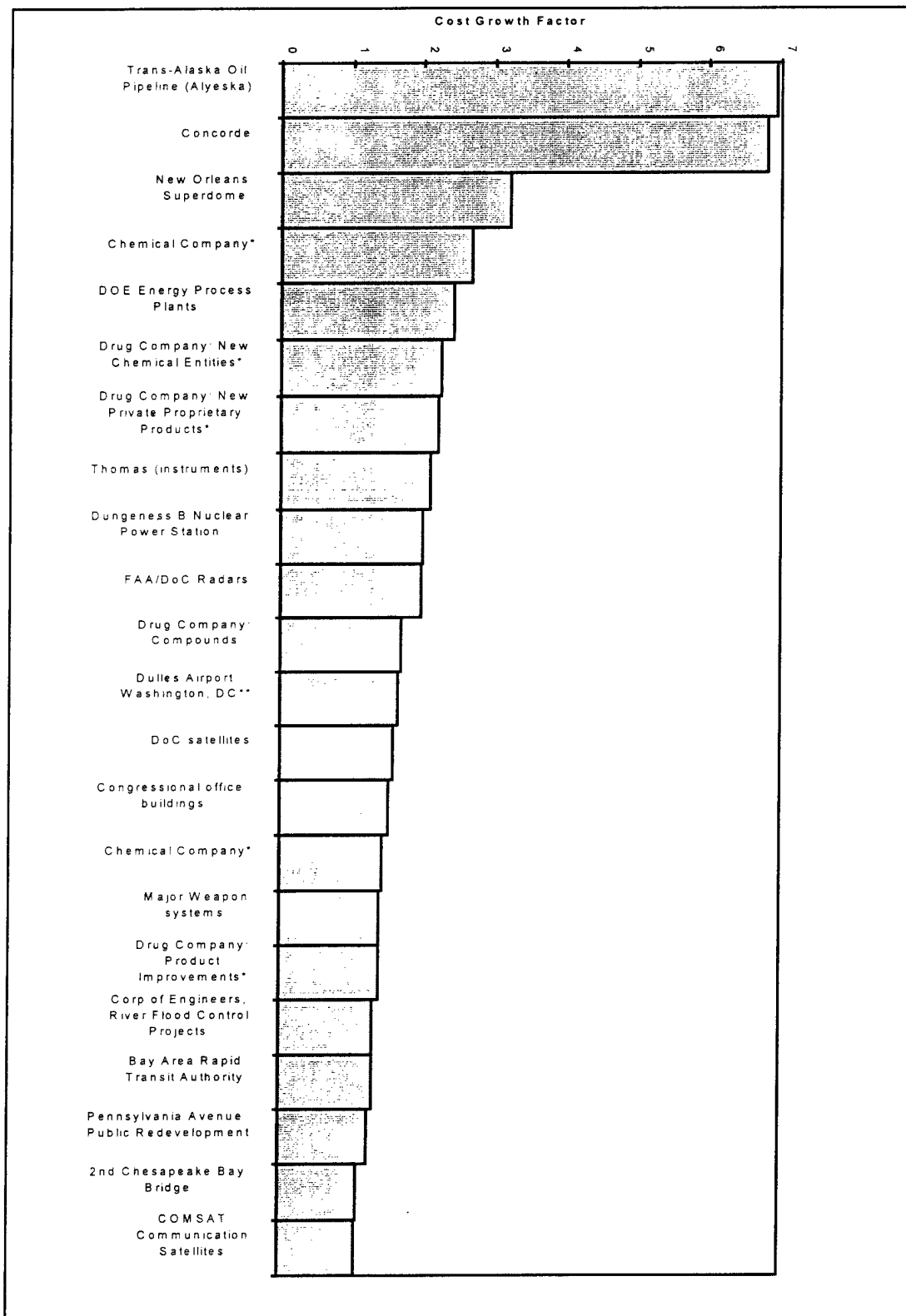
One part of the NSIA survey asked which C/SCSC concepts have been applied to other contracts or commercial applications. Although responses indicated very few contractors utilized the criteria fully in these situations, various concepts were used quite heavily. For instance, budget cost of work performed (BCWP) was utilized by over 70% and estimate at completion (EAC) and reporting methods by over 80% of respondents (NSIA, 1980: IX-16).

A 1997 GAO report also adds credence to the concept of earned value (GAO, 1997: 11). The report highlights the fact that commercial firms are adopting the concept of earned value more and more. Although many of these new implementations of earned value are being applied in a more streamlined manner than in the past, the basic concept of earned value is still very much alive and well. For example, United Defense Limited Partnership (a major defense contractor) has incorporated earned value into its entire

management structure. Also, Lockheed-Martin Missiles and Space has announced it is adopting earned value for all its contracts. These include contracts with military or commercial customers.

Biery highlights the fact that the military's cost growth may not look so bad when compared with other projects (1985: 12). In this particular article, he attempts to quantify the costs and benefits of competition in acquisition strategies. It's no secret that the military has experienced cost growth on many of its contracts. In fact, the Pentagon has attracted much criticism as a result of program cost growth. However, Biery provides a compelling table which compares cost growth of major weapon systems with various types of complex, technically ambitious non-military projects. Figure 3 is a graphical replication of Biery's table.

The cost growth in Figure 3 is defined by Biery as "the difference between the actual costs (or the most current estimate of actual costs) and the estimate made at the start of the system's development" (1985: 11). These growth factors were calculated in constant dollars to eliminate the effects of inflation. For example, the military weapon systems cost factor of 1.4 represents a 40 percent cost overrun. Further, Biery states that the actual and estimated costs are compared with one another on a similar quantity basis. Biery also states that "if one assumes that the technological advance sought in many new weapon systems is greater than that generally sought in commercial and non-defense projects, then [the data represented in this chart] may even understate the military cost record" (1985: 12).



*Note: Development costs only. **Note: Actual inflation was less than planned.

Figure 3. Cost Growth on Various Projects (Biery, 1985: 12)

Indeed, many public sector projects and private sector projects exhibited greater (sometimes significantly greater) cost growth than the military. Biery points to a number of management initiatives put into place in the early 1970s that may have had some positive impacts upon improving cost and schedule controls within the military acquisition environment. Several policies under the Packard initiatives are mentioned as well as the creation of the Cost Analysis Improvement Group. However, Biery does not mention specifically the possibility that earned value techniques within the Cost/Schedule Control Systems Criteria (C/SCSC) could have been responsible. We believe that C/SCSC requirements (that were not present on many of the other contracts) played a major role in minimizing cost growth on military acquisitions.

The fact that other U.S. government agencies have adopted earned value practices also lends support for its validity and merit. For example, the United States Office of Management and Budget requires “that cost, schedule and performance goals are identified that can be measured using an earned value management system or similar system” (OMB, 1997: 3). The United States Department of Energy adopted the C/SCSC criteria in 1975 and has imposed them on contractors doing business with them ever since (Fleming, 1992: 25). The National Aeronautic and Space Administration (NASA) also requires contractors to comply with the EVMS criteria on major acquisitions as described in Policy Directive NPD 9501 3.

The governments of Australia, Canada and Sweden are incorporating earned value techniques into many of their projects.

At the Trilateral Defense Industrial Cooperation Forum held in Washington, D.C. in September 1992, Australia, Canada and the United States agreed to set up the International Performance Management Council (IPMC). IPMC objectives are 1) to exchange information at the policy and administrative levels on respective C/SCSC programs, 2) to strive toward reciprocal recognition of contractors accepted as C/SCSC-compliant by each country, and to promote internationally the "earned value" management techniques embodied in C/SCSC... Since then, Sweden, New Zealand, and the United Kingdom have agreed to become members of the IPMC. (IPMC, 1997)

For more evidence of the merit of earned value, we could certainly examine the utilization rates of the reports generated by a C/SCSC compliant system. In the NSIA survey, participants were asked what levels of senior management use their cost performance reports (with their earned value measurements) for status information. The respondents indicated the report is utilized by: 99% of contract program managers; 57% of functional branch managers; 55% of finance controllers; 50% of company vice-presidents, as well as small portions of corporate vice presidents and other managers (NSIA, 1980: I-25).

One particular example of an extremely successful organization using an earned value-based management information system is at Levi Strauss' Albuquerque plant (Hatfield, 1996: 27). Each machine used to process material keeps track of actual costs and time as well as the number of garments processed and the extent to which they have been finished. This system generates a report resembling a Cost Performance Report (CPR) every hour. Through the use of tight variance thresholds, the company is able to

utilize management-by-exception to a very high degree. Positive variances are used as a basis for employee bonuses. Earned value management was such an integral part of their system, managers and floor supervisors say they could not imagine running their business without these hourly status reports.

Other evidence of earned value benefits can be found in a letter published in *Program Managers Newsletter* (Feedback, 1978). This letter discusses the cost avoidance due to improved discipline and management visibility from the implementation of C/SCSC. The government had decided to delete a scheduled task from the contract and requested a credit for the reduction in scope. Since none of the work being deleted had been started, the only obstacle was determining the value of the work. The work had been planned in the contractors C/SCSC system, so preparation of the proposal was almost effortless. Additionally, government review of the proposal was also simplified. The contractor and government were less than two percent apart at the start of negotiations, and settled on a price in minutes. The savings were quantified by assessing the proposal preparation, fact finding, and negotiation times. Total cost of proposal preparation was only \$200, compared to past proposal costs of \$10,000. The government used only eight person hours for fact finding versus the usual 100. Negotiations usually take 100 person hours, so total government savings (fact finding and negotiations) is estimated at \$5,000. The total savings was estimated to be approximately \$15,000 (Feedback, 1978: 22).

In another case, a program with two competing developers was canceled. The associated problem was in determining the target cost which the contractors' fees would

be based on. Using reports and planning from the contractor's C/SCSC validated system, the project office and one contractor reached agreement instantaneously, while it took three days for the other contractor. The immediate savings to the government was \$400,000, while the manpower savings may have been greater since a claims situation was avoided (Feedback, 1978: 22).

Future Benefits

There are many other benefits that could be realized in the future from the use of criteria-compliant systems. For instance, validated earned value data could be used to determine progress payments instead of the traditional percent complete approach. The percent complete approach has historically been used (without regard to actual work performed to date). No doubt, this method could very easily distort work accomplished and result in progress overpayments (or underpayments).

Fleming and Koppelman agree that "the fundamental guiding principle that should apply to all payments being made from the owner of a project to the contractors performing the project work [is that] all such payments should be made in concert with the physical work accomplished on the project" (Fleming and Koppelman 1995: C.2.1). Further, they suggest that all payments to the contractor be made at some value less than 100% of the total costs incurred which provides the contractor incentives to complete the project (Fleming and Koppelman, 1995, C.2.4).

Areas outside of the defense environment could also benefit from the use of earned value. For instance, Fleming and Koppelman offer a simplified approach of incorporating earned value into various types of projects (1996: 112). Although the value of this approach has yet to be fully tested, it would no doubt be faster, easier, and less costly to implement than the full blown version.

Nancy Singletary also suggests other uses of earned value techniques. She states “no longer just a method for meeting C/SCSC standards for the Department of Defense, Earned Value methodology is holding its own and paying its way in commercial industries, public and private sectors, manufacturing, financial institutions, pharmaceuticals, and other industries interested in optimizing the profit line or just breaking even” (1996: 28-29). Singletary also agrees that a major benefit of earned value is the ability to compare the progress of dissimilar projects (1996: 28-29).

Presutti echoes the idea that earned value could enhance the management capabilities of organizations outside the Defense industry. Plus, he adds, the documentation for this government process is readily available and virtually free (1993: 53).

Summary

Chapter II described the costs associated with complying with C/SCSC. In this chapter we have attempted to show benefits that may result from a contractor's use of C/SCSC on acquisition programs. Now that we have looked at the costs and benefits of

the criteria separately, in the next chapter we will look at them together in order to better understand their relationship.

IV. Cost vs. Benefits and the Implementation of EVMS

C/SCSC Costs versus Benefits

In Chapters II and III, we identified the costs and benefits of C/SCSC. Before we compare the costs and benefits, we will review conclusions from previous studies on this subject. Then, we will summarize our findings on the costs and benefits of the criteria. Next, we will show how data from criteria-compliant management control systems can be viewed within the framework of the usefulness of the information it provides. We will describe some of the various qualities of information; and how tradeoffs must be made by managers in determining how to maximize the usefulness of information for all customers. Finally, we will determine how the costs and benefits are affected by the switch to EVMS.

Several studies, including the Arthur D. Little study and the Coopers & Lybrand/TASC study, have made conclusions about the costs and benefits of C/SCSC. A National Security Industrial Association (NSIA) report cited that,

Although C/SCSC performance measurement criteria have been in existence for over 15 years, contractors still do not find them sufficiently productive or cost effective to use to any substantial extent in managing their business unless forced to do so by contractual requirement. What little is used voluntarily for analysis and control is applied at significantly higher levels in the cost isolation structure than is usually demanded under C/SCSC requirements imposed by customer or SAR team interpretation of the criteria. Apparently this limited application is judged to be considerably more cost effective, less burdensome documentation-wise, yet effective in management of the business (1980: 16). Another important finding concludes that, "While many contractors have voluntarily adopted the basic concept of earned value performance measurement, no more than 4%

indicate that they voluntarily use the full system that they are required to subject to Government procedural interpretations and acceptance conditions. (1980: 18)

Phase I of the Arthur D. Little study concluded that, “. . . the majority of respondents within each of the four populations believe that C/SCSC benefits to themselves outweigh its costs. However, the majorities were not large. They ranged from 53% to 62% in the four populations” (1983: I-2).

Additionally, this study questioned the usefulness of cost reports generated from C/SCSC-approved systems and found that, “. . . close to four-out-of-five respondents rated the reports as being either good or excellent in helping to determine the cost status of their contracts. However, for helping to determine aspects of contract status other than cost, less than half of the government program managers rated the reports as either good or excellent” (1983: 1-2).

Phase II of the Arthur D. Little study added to the surveyed information from Phase I by conducting in-depth interviews. Phase II concluded that, “The most important overall conclusion of the study is that C/SCSC is a valid concept and approach to controlling contractor performance” (1984: I-3). Phase II also noted that,

All four categories of managers agreed (ranging from 53% to 62%) that C/SCSC benefits to themselves outweighed its associated cost. However, the strength of this belief was less than that relating solely to C/SCSC effectiveness. The pattern of the data . . . appeared to suggest that perceptions of whether benefits outweigh costs were relatively elastic. In addition, these data appeared to be inversely related to the cost of system operation . . . (1984: III-2)

A joint DOD/NSIA report identified opportunities to improve the cost and schedule management process. The report found that, “Conclusions clearly indicate that

both DoD and industry place high importance on the need for cost/schedule management control systems. They also agree that change is necessary to improve the quality and efficiency of cost/schedule performance measurement and reporting” (1991: 1-1).

Additionally, the report found that, “More than 90 percent of all interviewees (DoD and industry) place extremely high importance on the need for standard cost/schedule management systems criteria as defined by DoDI 7000.2” (1991: 1-5).

A 1994 study requested by the Deputy Secretary of Defense and conducted by a joint Coopers & Lybrand and TASC project team looked at the impact of DOD regulations and oversight. C/SCSC ranked third among the top ten cost drivers, however only accounted for 0.9% of the total ‘value added’ costs (total contract costs less material costs). The study did not look at the benefits associated with C/SCSC regulatory compliance, but does state,

In general, industry views the general framework and principles of cost/schedule reporting positively. Sound program management requires regular analysis of expenditure and performance trends, and deviations must be addressed early to avoid overruns and delays. However, all contractors subject to C/SCSC agree that, as currently required by DoD, cost/schedule reporting is too detailed, repetitive, and voluminous to be used effectively as a management tool by either the government or industry, and that the requirement may in fact undermine program performance by diverting the time and attention of the company program manager. (1994: 22)

A 1997 GAO report presented a brief history of C/SCSC, identified problems with C/SCSC, and discussed means to overcome these problems, including the switch to the industry EVMS. The report stated,

The core concept of the CS\2 process--earned value--is recognized as a sound way to measure progress on major acquisition programs. Over the years, however, the process has evolved to where the needs of

some of its key users are being satisfied, while others are not. Specifically, DOD program managers are not satisfied with the timeliness of the CS\2 reports. Because the data contained in the reports are typically up to 2 months old, the reports do not function as an early warning system needed by program managers. Moreover, the process has not fully integrated cost, schedule, and technical data as intended. The want of such information can invite subjective and potentially optimistic judgments to fill the void. Contractors maintain that accommodating extensive government certification reviews, collecting and arraying data in prescribed categories, and preparing detailed reports requires significant effort and cost to the government and draws some of their engineering resources away from program execution. Commercial firms that use earned value systems produce reports more frequently, more quickly, and in less detail than the CS\2 process. Users outside the program offices--such as financial managers and cost estimators--find that the data generally meets their needs. These users generally place more value on consistency among cost categories and less value on timeliness than program managers (3).

In Chapters II and III, we concluded, separately, the costs and benefits of C/SCSC. The summarized costs and benefits may be looked at together in Tables 8 and 9.

Table 8. C/SCSC Costs

	C/SCS-Compliant Costs	'Normal' System Compliance Costs	Marginal Cost of C/SCSC Compliance
	Person Days	Person Days	Person Days
System Compliance Costs	1,086	605-752	334-481
System Design Costs	252	252	0
System Documentation Costs	101	50	50
Training Costs	184	184	0
System Implementation Costs	367	110-257	110-257
System Evaluation Costs	184	9	174
System Operating Costs (These costs are in hours)	$[40 + (2 * \# \text{ of CAs})]$ * (# of Post Validation CPR cycles)	50% of the C/SCSC-Compliant Costs	50% of the C/SCSC-Compliant Costs

Table 9. Benefits of C/SCSC

1.	Employment of a single management control system.
2.	Integration of cost, schedule and technical parameters.
3.	Resulting database that reflects a consistent and predictable performance history.
4.	Utility and stability of the cumulative Cost Performance Index (CPI_{CUM}) to monitor performance.
5.	The utility of the Schedule Performance Index (SPI) to monitor and quantify the value of the work scheduled against work performed.
6.	Utility of the CPI_{CUM} to statistically forecast low end range of completion costs.
7.	Utility of the CPI_{CUM} combined with SPI to forecast most likely completion cost.
8.	Utility of the To-Complete Performance Index (TCPI) to monitor remaining tasks.
9.	Utility of a periodic CPI to measure performance against a pre-set standard.
10.	The use of Management by Exception principles to focus management's attention on significant exceptions to the authorized plan.
11.	The validity and accuracy of the above mentioned "earned value benefits" are empowered by requirements embedded in the criteria.
12.	The ability to use valid earned value data to determine progress payments.
13.	A management discipline that may require contractors to do things better up front than they might have otherwise done.
14.	Evidence of smaller cost growth in the military than in many other commercial and non-DoD projects.

Summary of C/SCSC Costs versus Benefits

So how do the costs and benefits of the criteria relate? We encountered much difficulty at first in our attempts to analyze both together in order to arrive at some conclusion about the overall utility of the criteria. One approach compares the cost of C/SCSC to the cost overruns of projects not complying with C/SCSC.

Table 3, C/SCSC System Compliance Costs (% of Total Contract Value), identified several studies that estimated the costs of C/SCSC as a percentage of total contract value. The range of the cost of C/SCSC was from 0.1% - 5% of total contract

value. Figure 3, Cost Growth on Various Projects, compares the cost growth of non-DoD projects to DoD project cost growth. The associated 1985 paper by Biery found that DoD projects on average experience a 40% cost overrun. The average overrun of the non-DoD projects identified in the paper was 128%, with a range of 8% to 593% and a median of 70%. While it can not be determined if the difference is due to C/SCSC compliance, or other factors, it does indicate that 0.1% to 5% of total contract value is a small price to pay for the associated C/SCSC benefits.

Another approach that adds structure to this analysis goes back to basic accounting concepts. One of the main purposes of the criteria is to ensure that contractor management control systems provide data that can be transformed into useful information for decision makers.

The characteristics of information that make it a desirable commodity can be viewed as a hierarchy of qualities, with usefulness for decision making of most importance...Relevance and reliability are the two primary qualities that make accounting information useful for decision making...To be relevant, information must be timely and it must have predictive value or feedback value or both. To be reliable, information must have representational faithfulness and it must be verifiable and neutral. Comparability, which includes consistency, is a secondary quality that interacts with relevance and reliability to contribute to the usefulness of information. Two constraints are included in the hierarchy, both primarily quantitative in character. Information can be useful and yet be too costly to justify providing it. To be useful *and* worth providing, the benefits of information should exceed its cost. (FASB, 1993: 27)

Christensen developed a chart based upon this concept from the FASB (1989: 30).

His adaptation is tailored to the defense environment and is replicated in Figure 4.

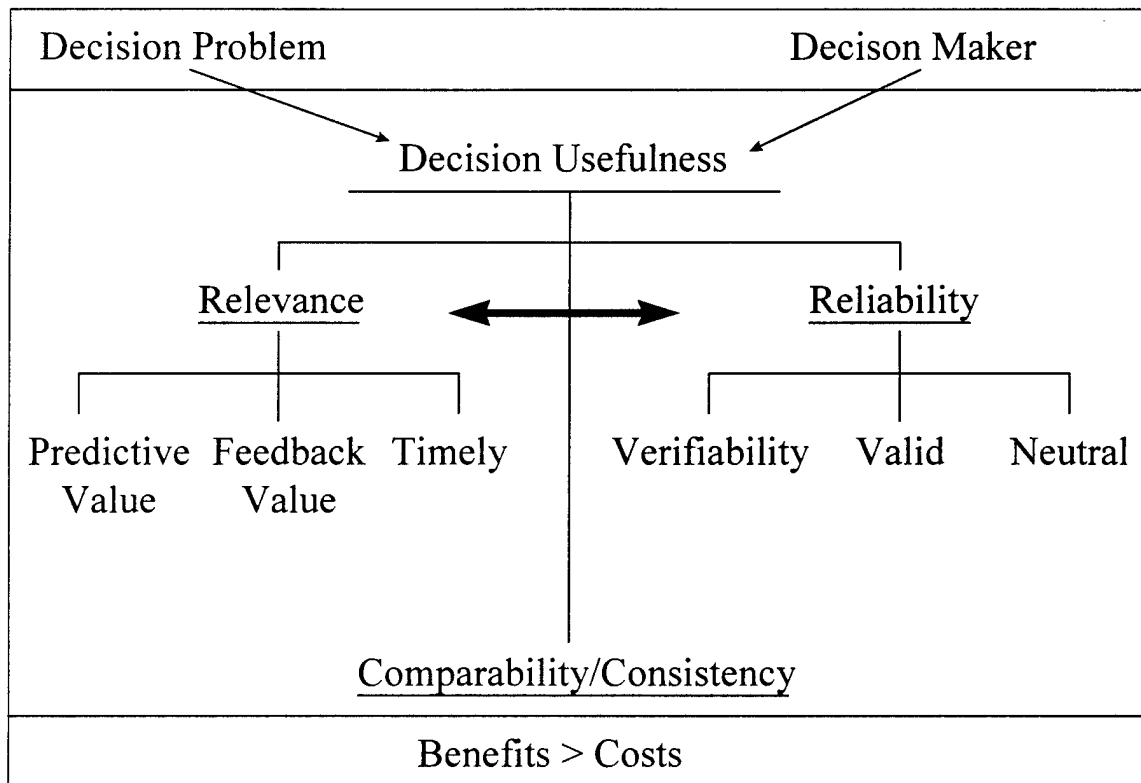


Figure 4. Information Quality and the Criteria

Let us view government regulatory requirements, such as C/SCSC or EVMS within the framework of Figure 4. One of the main products of a criteria-compliant system is cost, schedule, and technical information. At the top of the information quality hierarchy is decision usefulness. If the information produced is not useful for decision makers, then, of course, it adds costs but no benefits to the process. One of the difficulties associated with C/SCSC or EVMS is that it must serve several decision makers. Contractors, program managers, financial managers, engineers, program element managers (PEM), program executive officers (PEO), DCMC personnel, and Congressional members are all decision makers that use the information generated from a

criteria-compliant management control system. The amount and type of information needed by these different decision makers varies greatly. A financial manager may be interested in the costs of WBS level three elements, while a PEO may only be concerned with costs at the total program level. A GAO report details this concept:

An earned value system faces stiff and somewhat competing demands from its users: (1) providing the right analyses in time for program managers to use; (2) enabling adequate oversight and analysis of multiple programs beyond the program office level; and (3) minimizing the effort required of the contractor to provide the necessary systems, data, and analysis. (1997: 4)

The majority of these different needs must be met while balancing two very important characteristics: relevance and reliability.

Information relevance and reliability is a continuum where one is traded for the other. In order to obtain more reliable information, we may be forced to sacrifice some of the relevance of that information and vice versa. For example, if we want monthly cost information to be audited by an independent source, we gain reliability, but lose relevance as the auditing time will delay the delivery of the information to the decision maker. This also ties into the variety of decision makers' needs. A program manager's information needs may stress timely cost information, while a financial manager's may stress valid cost information.

If we consider the relevance portion of the diagram to be related to the benefits of the criteria and the reliability portion to the costs, then we can make some useful points. The implementation of the criteria generate costs that should be justified by the reliability of the information produced by a compliant system. From these compliant systems, reliable and relevant information is passed on to the user. As the quest for 'reliable'

information proceeds, costs increase, but, equally important, the relevance of the information starts to weaken. More reliable information can translate into more complicated management control systems, more detailed reporting, more information auditing, and higher costs. The reliability of the information is increased at the sacrifice of the relevance. Since cost reporting takes longer, and more detailed information is in the cost reports, it becomes harder for the user to filter out the needed information. Eventually, this leads to a very reliable management control system that is not as useful to the decision makers. On the other hand, a non-criteria-compliant management control system can generate top level cost information hourly, without being audited, but is the information reliable? It is easy to see how the delicate balance between reliability and relevance can affect the costs and benefits of C/SCSC or EVMS, especially coupled with the differences in user's needs.

Based on our research and the GAO's findings, we believe that the government progressively moved toward reliability and has lost some relevance in the process. This may have resulted in additional costs, and degraded the relevance of the information provided to managers. However, in light of recent reform initiatives, the focus seems to be shifting back towards relevance. We are not suggesting that, overall, the costs have outweighed the benefits. We simply believe that in its attempt to monitor and manage contracts, the government has focused more on reliability than was absolutely necessary. A 1997 GAO report says, "... CS² has been viewed by other users as a compulsory and burdensome financial reporting system. Moreover, it has not fully satisfied the need of

many program managers for up-to-date and integrated information on cost, schedule, and technical progress” (1997: 4).

It is no secret that many major DoD acquisition programs have experienced cost overruns. However, as we pointed out earlier, the DoD’s cost growth has been much lower than other major non-defense projects. But any process that utilizes public funds inefficiently should be scrutinized in hopes of eliminating wasteful, inefficient practices. The enormous monetary values of many defense contracts emphasize this point. For instance, a ten percent overrun on a contract may not sound so terrible to some individuals. Contrarily, if the ten percent overrun is on a one hundred million dollar contract, the overrun of ten million dollars now sounds much more significant. Small overruns are also not acceptable due to the sheer number of defense contracts. Collectively, these overruns can have a dramatic effect upon our resources and ultimately upon our defense capability.

As a result of past acquisition problems, the DoD has implemented more and more oversight mechanisms. One could argue that the requirements of C/SCSC could not have become more burdensome since the 35 criteria have remained virtually unchanged since their inception in 1967. However, the way in which these criteria have been interpreted and enforced may have become more burdensome to the contractor than was necessary.

EVMS - What Has Changed From C/SCSC?

In August 1996, five industry associations published the Industry Standard Guidelines for Earned Value Management Systems (EVMS), as a replacement to the C/SCSC criteria. The DoD formally recognized the guidelines of EVMS in December 1996 (GAO, 1997: 16).

The 32 EVMS criteria are very similar to the 35 C/SCSC criteria. For example, both sets of criteria are divided into five broad categories: organization; planning, scheduling and budgeting; accounting requirements; analysis and management reports; and revisions and data maintenance. However, there are some differences between the two sets of criteria worth noting. Comparison of the specific criteria is provided in Appendix A.

Essentially, the primary difference between the two sets of criteria lies in the acceptance procedures. Under C/SCSC, the government had to formally validate and accepted a contractor's management control system. The *Industry Standard Guidelines for Earned Value Management Systems* explains the self-certification concept. The guidelines state,

The process of self certification involves written corporate assurance that the company program management system meets the full intentions of the guidelines presented in this EVMS industry standard. The company is responsible for evaluation of its system and the certificate of self certification should be signed by the chief executive officer of the company involved. (Section 5)

The company can use outside resources such as peer groups, consultants, and government to assist in the self certification.

A 1997 GAO report cites, "DOD does not accept the self-certification provisions of the EVMS standard. Instead, it would like to find some middle ground between self-certification and traditional government certification" (17). The report also notes that specific data access rights, and the contractor's ability to change the baseline with only notification rather than approval are two other differences between C/SCSC and the new EVMS criteria (17).

The *Earned Value Implementation Guide* provides guidance on how the self-certification issue is to be handled. The guide states, "For all contracts requiring compliance with the criteria, the validity of the PMB will be sustained through the conduct of an Integrated Baseline Review (IBR)" (1996: 36). The guide goes into further detail about the objectives and approach of the IBR, and also discusses the compliance evaluation policy,

When the application of the Criteria is required, it is policy to ensure that: (1) no changes to contractors' existing EVMSs are required except those necessary to meet the intent of the criteria; (2) the contractor has properly implemented the EVMS on the contract under review and is using it as a mainstream program management tool; and, (3) the contractor is using the data from its own EVMS in reports to the government. (1996: 38)

Figure 5 shows that the choice of self-certification rests on the contractor, but the government must still accept the self-certification. The guide defines the conduct of the compliance evaluation, which is required if the contractor chooses to allow the government to review and validate its management control system.

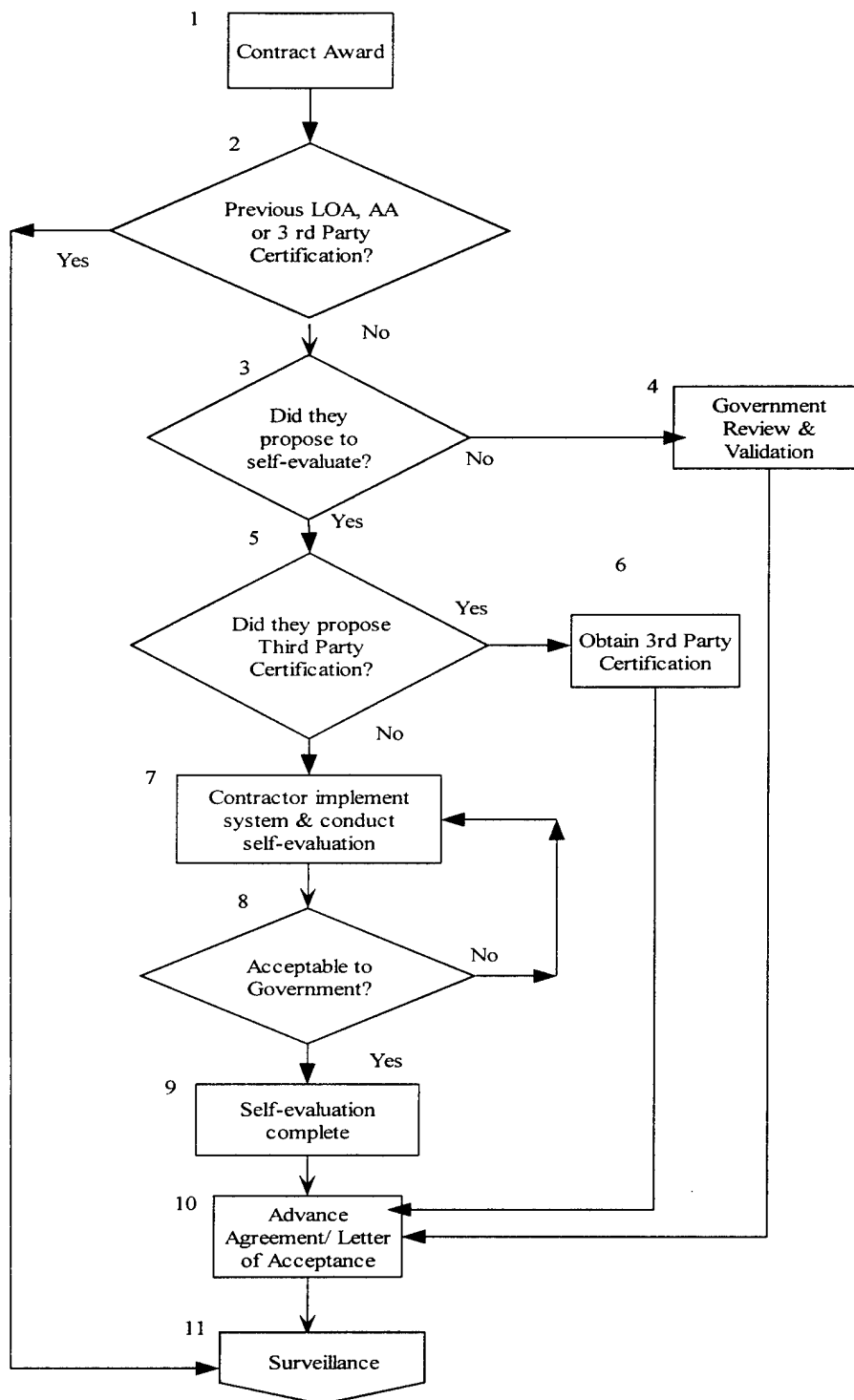


Figure 5. EVMS Post Contract Process

Further guidance on the EVMS criteria are found in changes to the FAR by the *Defense Federal Acquisition Regulation Supplement*. One specific change addresses the self-certification issue:

7. Section 252.234-7001 is revised to read as follows: 252.234-7001 Earned value management system. As prescribed in 234.005-71, use the following clause: Earned Value Management System (Mar 1997)

7(a) In the performance of this contract, the Contractor shall use an earned value management system (EVMS) meeting the criteria provided in DoD 5000.2-R, Mandatory procedures for Major Defense Acquisition Programs and Major Automated Information Systems.

7(b) If the Contractor has an EVMS that has been recognized by the cognizant Administrative Contracting Officer (ACO) as complying with the EVMS criteria (or an existing cost/schedule control system (C/SCS) that has been accepted by the Government), the Contractor shall apply the system to this contract within 60 calendar days after contract award or as otherwise agreed to by the parties.

7(c) If the Contractor does not have an EVMS that has been recognized by the cognizant ACO as complying with EVMS criteria (or does not have an existing C/SCS that has been accepted by the Government), the Contractor shall be prepared to demonstrate to the ACO that the EVMS complies with the EVMS criteria referenced in paragraph (a) of this clause.

7(d) The Government may require an integrated baseline review within 180 calendar days after (1) contract award, (2) the exercise of significant contract options, or (3) the incorporation of major modifications. The purpose of the integrated baseline review is for the Government and the Contractor to jointly assess areas, such as the Contractor's planning, to ensure complete coverage of the statement of work, logical scheduling of the work activities, adequate resourcing, and identification of inherent risks.

7(e) Unless a waiver is granted by the ACO, Contractor proposed EVMS changes require approval of the ACO prior to implementation. The ACO shall advise the Contractor of the acceptability of such changes within 30 calendar days after receipt of the notice of proposed changes from the Contractor. If the advance approval requirements are waived by the ACO, the Contractor shall disclose EVMS changes to the ACO at least 14 calendar days prior to the effective date of implementation.

7(f) The Contractor agrees to provide access to all pertinent records and data requested by the ACO or duly authorized representatives. Access is to permit Government surveillance to ensure that the EVMS complies, and continues to comply, with the criteria referenced in paragraph (a) of this clause.

7(g) The Contractor shall require those subcontractors specified in the contract for application of the EVMS criteria to comply with the requirements of this clause.

The previous examples describe how the DoD is implementing the self-certification of the EVMS standards. The question now becomes: how will the costs and benefits be impacted by the new EVMS criteria? It is easy to see that system evaluation costs will decrease as a result of the change to EVMS, but will the benefits be affected? Benefits eleven and twelve from Table 7 are the only benefits that may be affected by the switch to EVMS, specifically the self-certification provision. One may argue that without a full government review and validation of a contractor's management system, data from said system will not be valid. However, DCMC's compliance policy (detailed in Figure 3) for validating the contractor's management system and its corresponding data is intended to ensure that the EVMS criteria are met. As seen in Figure 5, step 8 allows the government to determine if the contractor's self-evaluation of their criteria-compliant management control system is acceptable. If the EVMS criteria are met, the data from the validated management control system should be valid. Thus, we conclude the change to EVMS will reduce the C/SCSC costs while not affecting the associated benefits.

Besides the switch to EVMS, there are many other changes that have come about as a result of acquisition reform. The DoD is moving more toward commercial practices in an attempt to improve the acquisition process and save money. Some of the major

differences between commercial earned value practices and traditional defense practices are outlined below:

Table 10. Commercial Versus DoD Earned Value Practices (GAO, 1997)

Characteristic	Commercial Program	Traditional DoD Program
Frequency of status reports	Weekly/bi-weekly	Monthly
Age of information	Real-time/weekly	Up to 60 days after reporting period ends
Method of data dissemination	Direct access to database	Mailing of reports on paper or disk
Work breakdown structure	Level 3	Level 3-7
Variance analysis reporting	Critical path items	All elements
Management focus	Technical and schedule	Costs

Status reports that are generated more frequently should result in more timely information and allow management to be more responsive. The ability to access the contractor's database directly could also enhance management's responsiveness. Also, it could minimize transcription and other errors that could occur from the previous method of mailing paper reports or disks.

Acquisition reform movements towards commercial practices can hopefully reduce the costs of operating a management control system, while still providing enough oversight and valid data as to not negate any of the benefits listed in table eight.

Conclusion

In this chapter, we have tried to synthesize the costs and benefits of the criteria. However, the costs we have identified are subjectively based upon many other studies, and the benefits are equally difficult to quantify. Any attempt to make a definitive conclusion about whether the benefits outweigh the costs or vice versa would be overly

bold and virtually defenseless. Instead, we would like to make some general comments concerning the criteria.

Many other major, private and public, non-military defense projects have experienced much higher cost growth. One might attribute the smaller cost growth for the military, at least partially, on DoD's requirement for the criteria (which were not required on most other projects identified in Table 2). Based on Table 2, DoD projects experience a 40% cost overrun on average. On the other hand, the average overrun of the non-DoD projects identified in Figure 2 was 128%, with a range of 8% to 593% and a median of 70%. Further, Table 3 identifies the cost of C/SCSC as ranging from 0.1% - 5% of total contract value. Although we can not determine if the difference is due to C/SCSC compliance, or other factors, it does indicate that 0.1% to 5% of total contract value is a small price to pay for the associated C/SCSC benefits.

The flexibility of the criteria allow, and even encourage, management control systems to be tailored to particular decision problems and contracts. However, we must remember that there are many customers that utilize information from these systems for different purposes. A requirement for excessively reliable information may result in less relevant, and more costly information from the system. Therefore, tradeoffs must be made to ensure these systems minimize costs while maximizing the usefulness of the information for all users.

V. Conclusions/Limitations/Future Research

Conclusions

The main thrust of this study was to compare the costs and benefits of C/SCSC together in order to determine the utility of the criteria. Additionally, we wanted to determine how the change to EVMS affects these costs and benefits. Let us review our original research questions and our findings.

Chapter II addresses our first research question: What are the costs of the criteria? This paper examines the marginal cost of C/SCSC, which is the difference between the cost of a C/SCSC-compliant management control system and the cost of a contractor's 'normal' management control system. Based on our analysis, we conclude that the marginal system compliance costs of a C/SCSC-compliant system ranges from 334-481 person days. Additionally, we conclude that the marginal system operating costs are 50% of the C/SCSC-compliant system operating costs. These cost findings are consistent with the 1994 Coopers & Lybrand/TASC study. However, where the Coopers & Lybrand/TASC study limited their conclusions by only addressing the costs of C/SCSC, we have addressed both the costs and benefits of C/SCSC.

Chapter III addresses the second research question: what are the benefits of the criteria? Our findings related to the benefits of the criteria are summarized in Table 9. Again, we must emphasize the fact that benefits associated with earned value analysis are

a part of the benefits of the criteria. Without the requirements spelled out by the criteria, the accuracy and the utility of the data provided by such a system would be very suspect.

Chapter IV addresses our third research question: how are the costs and benefits related? In comparing our identified costs with our identified benefits, a subjective viewpoint is taken. Because of the difficulties in assigning costs to the benefits, we were not able to conclude that the benefits outweigh the costs or vice versa. However, we show how the benefits and costs are related in terms of the relevance and reliability of cost data produced by the contractor's cost control systems. There is a trade-off which managers make between relevance and reliability that affects both the costs and benefits of information produced by a C/SCSC or EVMS compliant management control system.

Chapter IV also addresses the fourth and final research question: how will the move to EVMS affect these costs and benefits? The change to EVMS will reduce the contractor's system certification costs. Other costs as well as the benefits of C/SCSC will be unchanged as a result of the switch to EVMS. Also, we believe EVMS is a step in the right direction, but the impacts of this move, by itself, will most likely result in only modest improvements over C/SCSC.

Limitations

Although this study was an attempt to objectively compare the costs and benefits of the criteria, there are limitations. Many of the major studies that we draw upon in this thesis were based on questionnaires. Questionnaires reflect individual opinions which are

subjective. However, the very results of many of these studies would seem to validate their findings. For example, we would expect contractor's to generally oppose government oversight requirements. Many respondents might downplay the utility of requirements such as C/SCSC, even if they believed them to be critical tools for successful management. However, many of the studies that we have referenced show significant support by government and contractor personnel alike. We should point out that many of these same supporters acknowledged that there were some burdensome areas that needed improvement. Many of the problems related to C/SCSC are associated with its implementation. Better training and other steps are being taken to help minimize the problems associated with implementation. The switch to EVMS and other acquisition reform initiatives should also help ease some of the problems experienced in the past.

Future Research

Any effort that could serve to lessen the burden on defense contractors, while still providing the needed oversight mechanisms for government personnel would certainly be welcomed. Any such efforts would probably result in much needed cost savings. This need is greater than ever before because of steadily declining defense budgets. Most likely, these budgets will remain at levels much lower than experienced in the past. However, the United States must still maintain a strong military force to counter potential threats. Thus, the adage "do more with less" takes on even greater meaning. The acquisition of major military weapon systems is a very complicated and expensive

endeavor. The U.S. defense policy has focused on quality weapon systems rather than quantity for many years. Indeed, we have enjoyed technological advantages over most of our adversaries. However, the very nature of these cutting edge technology acquisitions results in very complex weapon systems. The complexities of these systems, coupled with DoD's need for oversight, have resulted in a very cumbersome acquisition process. As a result, many reform initiatives have been promulgated in order to reduce non-value-added tasks related to this process in hopes that cost savings could be obtained. At the same time, government representatives must have the proper level of oversight to ensure that needed weapons systems are delivered on time to meet the threat, and to ensure that public funds are being utilized efficiently. The switch to EVMS is a step in the right direction, but we must be careful that we do not go too far in our reform efforts.

Future research efforts might be aimed at better defining the optimal level of oversight requirements. We believe we have shown how C/SCSC has been a very effective tool in the past. But, could there be any new modifications to the criteria that could better serve the process?

Other future research efforts might be able to more objectively, in an empirical sense, determine the costs of the criteria. Attempts to quantify the costs of C/SCSC in the past have been very subjective. Today, many commercial organizations are using various earned value techniques even without being required to utilize them. One solution might be to find a private firm that has both a government and non-government major project that utilize earned value techniques on each. If such a firm can be found, and the two projects are somewhat similar in scope and monetary value, then a comparison could be

made to determine the costs on the government contract explicitly related to criteria requirements.

We strongly recommend that anyone either partaking in related research efforts or looking for more information on earned value reference the earned value homepage located at <http://www.acq.osd.mil/pm/>.

Appendix A: A Comparison of DoD and Industry Criteria (GAO and NSIA, 24-28)

C/SCS CRITERIA	EVMS CRITERIA
Organization	Organization
1. Define all authorized work and related resources to meet the requirements of the contract, using the contract work breakdown structure (WBS).	1. Define the authorized work elements for the program. A work breakdown structure (WBS), tailored for effective internal management control, is commonly used in this process.
2. Identify the internal organizational elements and the major subcontractors responsible for accomplishing the authorized work.	2. Identify the program organizational structure including the major subcontractors responsible for accomplishing the authorized work, and define the organizational elements in which work will be planned and controlled.
3. Provide for the integration of the contractor's planning, scheduling, budgeting, work authorization and cost accumulation systems with each other, the contract work breakdown structure, and the organizational structure.	3. Provide for the integration of the company's planning, scheduling, budgeting, work authorization and cost accumulation processes with each other, and as appropriate, the program work breakdown structure and the program organizational structure.
4. Identify the managerial positions responsible for controlling overhead (indirect costs).	4. Identify the company organization or function responsible for controlling overhead (indirect costs).
5. Provide for integration of the contract work breakdown structure with the contractor's functional organizational structure in a manner that permits cost and schedule performance measurement for contract work breakdown structure and organizational elements.	5. Provide for integration of the program work breakdown structure and the program organizational structure in a manner that permits cost and schedule performance measurement by elements of either or both structures as needed.
Planning and Budgeting	Planning, Scheduling, and Budgeting
6. Schedule the authorized work in a manner that describes the sequence of work and identifies the significant task interdependencies required to meet the development, production, and delivery requirements of the contract	6. Schedule the authorized work in a manner which describes the sequence of work and identifies significant task interdependencies required to meet the requirements of the program.
7. Identify physical products, milestones, technical performance goals, or other indicators that will be used to measure output.	7. Identify physical products, milestones, technical performance goals, or other indicators that will be used to measure progress.
8. Establish and maintain a time-phased budget baseline at the cost account level against which contract performance can be measured. Initial budgets established for this purpose will be based on the negotiated target cost. Any other amount used for performance measurement purposes must be formally recognized by both the contractor and the Government.	8. Establish and maintain a time-phased budget baseline, at the control account level, against which program performance can be measured. Budget for far-term efforts may be held in higher level accounts until an appropriate time for allocation at the control account level. Initial budgets established for performance measurement will be based on either internal management goals or the external customer negotiated target cost including estimates for authorized but undefinitized work. On government contracts, if an over target baseline is used for performance measurement reporting purposes, prior notification must be provided to the customer.

9. Establish budgets for all authorized work with separate identification of cost elements (labor, material, etc.).	9. Establish budgets for authorized work with identification of significant cost elements (labor, material, etc.) as needed for internal management and for control of subcontractors .
10. To the extent the authorized work can be identified in discrete, short span work packages, establish budgets for this work in terms of dollars, hours, or other measurable units. Where the entire cost account can not be subdivided into detailed work packages, identify far term effort in larger planning packages for budget and scheduling purposes	10. To the extent it is practical to identify the authorized work in discrete work packages, establish budgets or his work in terms of dollars, hours, or other measurable units. Where the entire control account is not subdivided into work packages, identify the far term effort in larger planning packages for budget and scheduling purposes.
11. Provide that the sum of all work package budgets, plus planning package budgets within a cost account equals the cost account budget.	11. Provide that the sum of all work package budgets plus planning package budgets within a control account equals the control account budget.
12. Identify relationships of budgets or standards in work authorization systems to budgets for work packages.	
13. Identify and control level-of-effort activity by time-phased budgets established for this purpose. Only that effort which cannot be identified as discrete, short span work packages or as apportioned effort may be classed as level-of-effort.	12. Identify and control level of effort activity by time-phased budgets established for this purpose. Only that effort which is unmeasurable or for which measurement is impractical may be classified as level of effort.
14. Establish overhead budgets for the total costs of each significant organizational component whose expenses will become indirect costs. Reflect in the contract budgets at the appropriate level the amounts in overhead pools that are planned to be allocated to the contract as indirect costs.	13. Establish overhead budgets for each significant organizational component of the company for expenses which will become indirect costs. Reflect in the program budgets, at the appropriate level, the amounts in overhead pools that are planned to be allocated to the program as indirect costs.
15. Identify management reserves and undistributed budget.	14. Identify management reserves and undistributed budget.
16. Provide that the contract target cost plus the estimated cost of authorized but unpriced work is reconciled with the sum of all internal contract budgets and management reserves	15. Provide that the program target cost goal is reconciled with the sum of all internal program budgets and management reserves.
Accounting	Accounting Considerations
17. Record direct costs on an applied or other acceptable basis in a manner consistent with the budgets in a formal system that is controlled by the general books of account.	16. Record direct costs in a manner consistent with the budgets in a formal system controlled by the general books of account.

18. Summarize direct costs from cost accounts into the work breakdown structure without allocation of a single cost account to two or more work breakdown structure elements.	17. When a work breakdown structure is used, summarize direct costs from control accounts into the work breakdown structure without allocation of a single control account to two or more work breakdown structure elements.
19. Summarize direct costs from the cost accounts into the contractor's functional organizational elements without allocation of a single cost account to two or more organizational elements.	18. Summarize direct costs from the control accounts into the contractor's organizational elements without allocation of a single control account to two or more organizational elements.
20. Record all indirect costs which will be allocated to the contract.	19. Record all indirect costs which will be allocated to the contract.
21. Identify the bases for allocating the cost of apportioned effort.	
22. Identify unit costs, equivalent unit costs, or lot costs as applicable.	20. Identify unit costs, equivalent units costs, or lot costs when needed.
<p>23. The contractor's material accounting system will provide for:</p> <p>(1) Accurate cost accumulation and assignment of costs to cost accounts in a manner consistent with the budgets using recognized, acceptable costing techniques.</p> <p>(2) Determination of price variances by comparing planned versus actual commitments.</p> <p>(3) Cost performance measurement at the point in time most suitable for the category of material involved, but no earlier than the time of actual receipt of material.</p> <p>(4) Determination of cost variances attributable to the excess usage of material.</p> <p>(5) Determination of unit or lot costs when applicable.</p> <p>(6) Full accountability for all material purchased for the contract, including the residual inventory.</p>	<p>21. For EVMS, the material accounting system will provide for:</p> <p>(1) Accurate cost accumulation and assignment of costs to control accounts in a manner consistent with the budgets using recognized, acceptable, costing techniques.</p> <p>(2) Cost performance measurement at the point in time most suitable for the category of material involved, but no earlier than the time of progress payments or actual receipt of material.</p> <p>(3) Full accountability of all material purchased for the program including the residual inventory.</p>

Analysis	Analysis and Management Reports
<p>24. Identify at the cost account level on a monthly basis using data from, or reconcilable with, the accounting system:</p> <p>(1) Comparison of budgeted cost for work scheduled and budgeted cost of work performed;</p> <p>(2) Comparison of budgeted cost for work performed and actual (applied where appropriate) direct costs for the same work; and</p> <p>(3) Variances resulting from the comparisons between the budgeted cost for work scheduled and the budgeted cost for work performed and between the budgeted cost for work performed and actual or applied direct costs, classified in terms of labor, material, or other appropriate elements together with the reasons for significant variances.</p>	<p>22. At least on a monthly basis, generate the following information at the control account and other levels as necessary for management control using actual cost data from, or reconcilable with, the accounting system:</p> <p>(1) Comparison of the amount of planned budget and the amount of budget earned for work accomplished. This comparison provides the schedule variance.</p> <p>(2) Comparison of the amount of the budget earned the actual (applied where appropriate) direct costs for the same work. This comparison provides the cost variance.</p>
<p>25. Identify on a monthly basis, in the detail needed by management for effective control, budgeted indirect costs, actual indirect costs, and cost variances with the reasons for significant variances.</p>	<p>23. Identify budgeted and applied (or actual) indirect costs at the level and frequency needed by management for effective control, along with the reasons for any significant variances</p>
<p>26. Summarize the data elements and associated variances listed in subparagraphs a.(1) and (2), directly above, through the contractor organization and work breakdown structure to the reporting level specified in the contract.</p>	<p>24. Summarize the data elements and associated variances through the program organization and/or work breakdown structure to support management needs and any customer reporting specified in the contract.</p>
<p>27. Identify significant differences on a monthly basis between planned and actual schedule accomplishment and the reasons.</p>	<p>25. Identify, at least monthly, the significant differences between both planned and actual schedule performance and planned and actual cost performance, and provide the reasons for the variances in the detail needed by program management.</p>
<p>28. Identify managerial actions taken as a result of criteria items in paragraphs a. through d., directly above.</p>	<p>26. Implement managerial actions taken as the result of earned value information.</p>
<p>29. Based on performance to date, on commitment values for material, and on estimates of future conditions, develop revised estimates of cost at completion for work breakdown structure elements identified in the contract and compare these with the contract budget base and the latest statement of funds requirements reported to the Government.</p>	<p>27. Develop revised estimates of cost at completion based on performance to date, commitment values for material, and estimates of future conditions. Compare this information with the performance measurement baseline to identify variances at completion important to company management and any applicable customer reporting requirements including statements of funding requirements.</p>

Revisions and Access to Data	Revisions and Data Maintenance
30. Incorporate contractual changes expeditiously, recording the effects of such changes in budgets and schedules. In the directed effort prior to negotiation of a change, base such revisions on the amount estimated and budgeted to the functional organizations.	28. Incorporate authorized changes in a timely manner, recording the effects of such changes in budgets and schedules. In the directed effort prior to negotiation of a change, base such revisions on the amount estimated and budgeted to the program organizations.
31. Reconcile original budgets for those elements of the work breakdown structure identified as priced line items in the contract, and for those elements at the lowest level in the program work breakdown structure, with current performance measurement budgets in terms of changes to the authorized work and internal replanning in the detail needed by management for effective control.	29. Reconcile current budgets to prior budgets in terms of changes to the authorized work and internal replanning in the detail needed by management for effective control.
32. Prohibit retroactive changes to records pertaining to work performed that would change previously reported amounts for direct costs, indirect costs, or budgets, except for correction of errors and routine accounting adjustments.	30. Control retroactive changes to records pertaining to work performed that would change previously reported amounts for actual costs, earned value, or budgets. Adjustments should be made only for correction of errors, routine accounting adjustments, effects of customer or management directed changes, or to improve the baseline integrity and accuracy of performance measurement data.
33. Prevent revisions to the contract budget base except for Government-directed changes to contractual effort.	31. Prevent revisions to the program budget except for authorized changes.
34. Document internally the changes to the performance measurement baseline and notify expeditiously the procuring activity through prescribed procedures.	32. Document changes to the performance measurement baseline.
35. Provide the Contracting Officer and the Contracting Officer's authorized representatives with access to the information and supporting documentation necessary to demonstrate compliance with the cost/schedule control systems criteria.	

Appendix B: Abstracts of Previous C/SCSC Cost and Benefit References

Title: Preface to C/SCSC White Paper

Author: Abba, Wayne

Format: Article

Journal: Program Manager Volume 15

Date: November-December 1986

This paper summarizes the objectives of C/SCSC and the associated cost performance reports, as well as what can and cannot be expected from their use. First, the objectives and requirements of C/SCSC are given. Next, the article points out the necessity of establishing a baseline and how it interacts with earned value management. There is a brief discussion of how the government validates the contractor's management control system to ensure it complies with the C/SCSC requirements. There is also a brief narrative about the Cost Performance Report (CPR)-the summary report provided to the government from the contractor's approved management control system.

Next, the author talks about challenges such as implementation time and system discipline requirements that result from implementing C/SCSC. Although not a direct result of the criteria, these issues can affect the cost of implementing and operating a C/SCSC compliant management system. The author highlights the fact that the costs of C/SCSC, which some proclaim to be excessive, are extremely difficult to quantify. It is almost impossible to separate the additional costs of C/SCSC from the management costs that would be incurred anyway. Some reasons for improper implementation are given along with a brief discussion of the Cost/Schedule Status Report (C/SSR).

Finally, the paper asserts that a C/SCSC-compliant system is the best tool available to assure contractor use adequate cost and schedule management control systems. This will ensure that valid cost and schedule performance data are generated allowing managers to make good business decisions.

Title: Cost Growth and the Use of Competitive Acquisition Strategies

Author: Frederick P. Biery

Format: Article

Date/Published: Presented at the 1985 National Estimating Society Conference

Pages: 11-17

This article was an attempt to quantify the costs and benefits of competition in acquisition strategies. It's no secret that the military has experienced cost growth on most of its contracts. In fact, the Pentagon has attracted much criticism as a result of program cost growth. However, the author hints that the military's cost growth may not look so bad when compared with other projects. A table is provided summarizing cost growth experienced by complex, technically ambitious non-military projects. Indeed, many public sector projects and private sector projects exhibited greater (sometimes significantly greater) cost growth than the military. The author points to the variety of management initiatives put into place in the early 1970s which may have had some positive impacts upon improving cost and schedule controls within the military. Several policies under the Packard initiatives are mentioned as well as the creation of the Cost Analysis Improvement Group. However, the author does not mention specifically the possibility that earned value techniques within the Cost/Schedule Control Systems Criteria (C/SCSC) could have played a part in helping to minimize cost growth.

Title: The Cost of the "Criteria"

Author: Richard Brodkorb, Decision Planning Corporation

Format: Report

Date/Published: 11 FEB 1992

Pages: 14

The purpose of this study is to determine what it costs to design and implement a management control system which is compliant with the C/SCSC. The main difficulty in determining the true cost of C/SCSC is separating the normal program control costs of good program management from the cost of a C/SCSC compliant system. The study separates the installation of C/SCSC compliant system into five areas: 1) system design, 2) system documentation, 3) training, 4) implementation, and 5) system evaluation.

This study assumes a generic R&D contract of \$75M, a contract duration of three years, and 80 cost accounts with 40 cost account managers. Additionally, the study assumes it takes twelve months to achieve a validated system.

System design costs require the full-time of a three or four person team for approximately four months. Additionally, a steering committee of senior managers will aid in the review of the system design. This study estimates that the system design effort, given the assumptions, will take 240 person days. The study concludes that the system design effort does not significantly vary with contract size. However, if large complex existing cost control systems are in place, this effort could increase.

During system documentation a system description and detailed operating procedures are developed. This study estimates system documentation to take 76 person days, which is also significantly independent of contract size.

Training involves the cost account managers, financial personnel, functional managers, and senior executives. The study indicates that cost account managers generally receive 20 to 40 hours of training, while other personnel receive 4 to 16 hours of training. The study estimated the total training effort to take 213 person days. This estimate varies directly with the size of the contract, as larger contracts require more cost account managers and other personnel.

The largest costs associated with implementing a C/SCSC compliant system is system implementation. Unfortunately, these costs are the most difficult to isolate from normal program management controls. This effort consists of the following activities: preparing the CWBS dictionary, preparing the cost account (CA) work authorization documents, preparing CA plans, reviewing CA plans, establishing the baseline log, opening charge numbers, analyzing cost account variances, preparing cost performance reports, and statusing cost account plans. The effort is estimated at 493 person days. An important note: this estimate is only for the twelve months prior to validation, further implementation costs will be incurred throughout the contract. This effort will also vary directly with contract size.

System evaluation includes three major Government reviews (Implementation review, readiness review, and demonstration review). These formal reviews can also be

supplemented with less formal visits, and contractor mock reviews. This effort is estimated at 175 person days, and will vary directly with contract size.

In addition to the costs in these five areas, there are support costs that are addressed. Administrative and reproduction-related efforts are estimated at 300 person days, and \$12,000 of supplies. C/SCSC compliant systems may be automated, but the costs of this are not included in this study.

This study concluded that the total pre-validation effort is 1,497 person days, and an additional \$12,000 of supplies. This equates to 6.24 person years, and assuming a burdened labor rate of \$50/hr, \$610,800. Any automation costs will add to this total. The study does note that doubling the contract size (to \$150M), only increases the costs by 30%.

Title: The DoD Regulatory Cost Premium: A Quantitative Assessment

Author: Coopers&Lybrand/TASC

Format: Deputy Secretary of Defense Requested Study

Date/Published: December 1994

Pages: 70

DoD and Congress have developed a complex regulatory environment intended to maintain public accountability in defense acquisition and prevent contractor abuses. The need to protect against contracting abuses must be balanced by a concern for the cost of this oversight. Many defense contractors now find that their core capability often has relatively little to do with technical capability or efficiency, and a lot to do with their ability to deal with the government and comply with its requirements. The purpose of this study is to assist DoD's reform efforts by providing credible, empirically-based estimates of the industry costs impact of DoD regulation and oversight.

Specifically, this study measured value added costs which are equal to total costs minus material costs. To determine the DoD cost premium, cost center managers were asked to estimate the cost impact on specific activities of substituting the best commercial practices for all DoD regulation and oversight. To simplify:

$$\boxed{\text{DoD Cost Premium}} = \boxed{\text{Actual Cost of Activity}} - \boxed{\text{Activity Cost Without DoD Regs \& Oversight}}$$

The DOD cost premium percentage is then equal to the contractor compliance costs divided by the value added costs. In this study, C/SCSC compliance ranked as the third highest DoD cost premium. The study cites that C/SCSC accounts for 0.9% of total value added costs, and 5.1% of the total cost premium. Compliance costs were collected for both C/SCSC costs, and C/SSR costs. The study notes that C/SCSC control requirements have a major cost impacts on two sites, and are significant at three other sites. Program managers devote a significant share of their time performing variance analysis and preparing the reports. Finance personnel monitor reporting compliance, develop and maintain automated reporting system, generate and format the budget vs. Cost data in the periodic reports, and resolve related progress payment issues with the government.

It is important to note that this study did not address the associated benefits that result from the costs of C/SCSC compliance. In determining the usefulness of C/SCSC, both the costs and benefits must be addressed. Every commodity, including information, has associated costs. Only after looking at the benefits of said commodity can one determine if the commodity is useful. Although this study did not address the benefits, it did look at the contractors' perceptions of C/SCSC.

In general, industry views the framework and principles of C/SCSC positively. Sound program management requires regular analysis of expenditure and performance trends, and deviations must be addressed early to avoid overruns and delays. However, all contractors subject to C/SCSC agree that reporting is too detailed, repetitive, and voluminous to be used effectively as a management tool by either the government or

industry, and that the requirement may undermine program performance by diverting the time and attention of the program manager. Industry suggests that DoD require reporting to summary levels in the WBS structure only; limit variance analysis to only those deviations that truly warrant analysis and corrective actions; or discard C/SCSC and replace with standardized commercial cost and schedule reporting.

Title: Cost/Schedule Control Systems Criteria: It may be more than we think

Author: Irwin J. Faibisch

Format: Article

Date/Published: Program Manager: September/October 1991

Pages: 30-33

C/SCSC are often defined as criteria which, when utilized properly, integrate cost schedule and technical performance into a singular management control system to promote better overall management of a project. The author discusses how the technical performance aspect has lost some of its meaning in the definition. He states that C/SCSC's principal value lies in its program control and planning attributes. Although the author believes reports generated by a C/SCSC system are important, he believes that too much emphasis is placed on them. They are merely after the fact reports that tell us where we've been and are more reactive in nature. He strongly advocates the need to use C/SCSC internally, in real-time, so that managers can take appropriate action at the most opportune time-as problems occur. In this way, they can best be tied to technical accomplishment indicators.

Title: FEEDBACK The Cost of C/SCSC

Author:

Format: A letter received by a DSMC faculty member in the Program Managers Newsletter

Date/Published: Jan-Feb 1978

Pages:

This letter discusses the cost avoidance due to improved discipline and management visibility from the implementation of C/SCSC. The government had decided to delete a scheduled task from the contract and request a credit for the reduction in scope. Since none of the work being deleted had been started, the only obstacle was determining the value of the work.

The work had been planned in the contractors C/SCSC system, so preparation of the proposal was almost effortless. Additionally, government review of the proposal was also simplified. The contractor and government were less than 2% apart at the start of negotiations, and settled on a price in minutes.

The savings were quantified by assessing the proposal preparation, fact finding, and negotiation times. Total cost of proposal preparation was only \$200, compared to past proposal costs of \$10,000. The government used only eight person hours for fact finding versus the usual 100. Negotiations usually take 100 person hours, so total government savings (fact finding and negotiations) is estimated at \$5,000. The total savings was estimated to be approximately \$15,000.

In another case, a program with two competing developers was canceled. The associated problem was in determining the target cost which the contractors' fees would be based on. Using reports and planning from the contractor's C/SCSC validated system,

the project office and one contractor reached agreement instantaneously, while it took three days for the other contractor. The immediate savings to the government was \$400,000, while the manpower savings may have been greater since a claims situation was avoided.

Title: Earned value project management

Author: Fleming, Q. W., & Hoppleman, J. M.

Format: Book

Published: Upper Darby Pennsylvania: Project Management Institute, 1996

Total Pages: 141

In this book, the authors provide a very simple, yet quite comprehensive discussion of the earned value concept. The first part of the book describes what earned value means, why it came about and how it has evolved. The next part of the book details how to implement earned value and use it to manage more effectively. The last chapter of the book discusses a simplified method of using earned value for private sector applications.

Chapter three is especially useful for our thesis effort. Here the authors list ten of the most important contributions resulting from the employment of earned value based on their review of the existing body of knowledge on the subject. A brief summary of these benefits are described below.

1. The employment of a single management control system providing accurate, consistent, reliable, and timely data that management at all levels can use to monitor performance throughout the life cycle of a project or a repetitive production effort.

The authors point out the problems encountered in the past resulting from firms keeping multiple sets of books. Data provided to project managers, senior management, financial analysts and others often was inconsistent. Fortunately, earned value

management standards eliminates this problem by requiring one system as outlined above.

2. A management approach that integrates the technical scope of work, the schedules, and the costs, allowing for the continuous measurement of integrated performance throughout the life cycle of the project or a production effort.

The advent of the Work Breakdown Structure (WBS) in the early 1960s gave us the ability to integrate cost, technical and schedule aspects of a project. Instead of projects being defined and measured by parochial interests in a non-integrated manner as was frequently the case in the past, now performance measurement could take place in a much more highly integrated manner. This new integrated approach served to help various functional personnel speak a common project language as never before. Further, various functional metrics became much easier to relate to each other.

3. Documented empirical data collected from over 700 DOD contracts...reflecting a pattern of consistent and predictable performance history (Beach 1990).

The analysis of these contracts that employ earned value has provided some important insights about government contracts. Sadly enough, after a project is about 15% complete, history has shown there is very little chance that any overruns can be overcome. In fact, studies show that the overruns usually will get worse. We can however, usually predict the final cost and schedule this early in a project within a predictable range of values based on historical performance.

4. The utility and the stability of the cumulative Cost Performance Index-CPI(e) based on cost efficiencies to continuously monitor the performance trends of a project.

Again, using cumulative contract performance data, management is able to assess the performance to date and to predict the final performance results quite well at a very early point.

5. The utility of the Schedule Performance Index (SPI) to monitor and quantify the value of the work scheduled and to compare it against the value of work physically performed.

A contractor that uses earned value management standards can easily compute this index which allows us to determine how far ahead or behind the planned schedule we are. The SPI can be used in conjunction with the Critical Path Method (CPM) to help manage the project schedule more effectively.

6. The utility of the cumulative Cost Performance Index(e) to statistically forecast a “low-end” range of estimated costs at completion.

A contractor that uses earned value management standards correctly can also compute the cumulative CPI quite easily. This index provides what many consider to be the best case or “low end” amount of funds needed to finish the effort. This index has proven to be a very stable indicator of performance.

7. The utility of the cumulative Cost Performance Index(e) combined with the Schedule Performance Index to statistically forecast the “most likely” range of estimated costs at completion.

Combining both indexes allows us to account for the compounding effects of performance that is both behind schedule and over cost. This method is considered by some to be a good method to estimate “most likely” final cost results.

8. The utility of the To-Complete Performance Index (TCPI) to monitor the remaining project tasks against a specific management financial goal.

Basically, this index is calculated by dividing the remaining work by the remaining budget (or a revised budget goal). The resulting index shows what level of performance must be attained to successfully reach this goal.

9. The utility of a weekly (or periodic) Cost Performance Index-CPI(p) based on the actual performance it took to achieve a planned production standard.

A periodic CPI can be used by industrial engineers or others to track the cost performance achieved against an established production standard for a given period.

10. The use of Management by Exception (MBE) principles to focus management's attention on significant exceptions to the authorized plan, thus allowing management to effectively monitor all critical aspects of performance and then develop and apply timely corrective actions.

Obviously, it is a major benefit for management to be able to oversee the performance of a project without having to delve into minute details.

Title: The Cost of C/SCSC

Author: Gadeken, Owen C. and Tison, Thomas S.

Format: Article in Program Manager

Date/Published: July-August 1983

Pages: 6

The purpose of this study is to analyze the cost impact of implementing C/SCSC. The study approaches this by analyzing the effect of implementing C/SCSC on a hypothetical, well-managed company.

The authors take the approach that the use of C/SCSC is very similar to the use of engineering specifications and design criteria. Contractors build their widgets in accordance with the specifications, but have the flexibility to propose any design such that it meets the specifications. They emphasize that the C/SCSC are not a management system, but rather standards for evaluating contractor management control systems. An interesting note is that the C/SCSC do not require the submission of any reports, but specify the reporting capabilities that the contractors' systems must have. The type and detail of reports is then selected by the program office.

The major difficulty in assessing the cost of C/SCSC is identifying costs uniquely attributable to C/SCSC. Validation reviews and system documentation are clearly related to C/SCSC. However, planning, budgeting, variance analysis, and other daily activities are difficult to separate from normal management processes. Other complicating factors include the modification effort of the contractor's existing system, the government review team's standards, and the attitude of the contractor when it reports C/SCSC costs.

Past studies indicate that contractor bias plays a role in determining the costs attributed to C/SCSC.

To determine the cost of C/SCSC, this study moves to the viewpoint of a hypothetical well-managed company with the following assumption: the company has a completely integrated management and control system. The authors identify many weaknesses associated with their approach. First, there is no such thing as an ideal, well-managed company. Next, the analysis is highly subjective. Finally, the costs or range of costs of implementing C/SCSC are not quantified.

The study begins its analysis by evaluating the company in the five criteria areas of C/SCSC. The organizational criteria require the contractor to define all of the work to be performed under the contract, and to assign this work, using a CWBS, to organizations responsible for it. These criteria represent basic management principles that any well-managed company can meet with minimal additional effort.

The planning and budget criteria require all authorized work to be planned, scheduled, budgeted, and authorized. Sound management principles suggest that tasks must be planned and scheduled, assigned budgets, and authorized work. These principles should also be found in a well-managed company. Implied in these criteria are planning at levels of detail that may or may not be found in a well-managed company. The planning down to cost accounts and work packages may be effort not usually performed by a well-managed company.

The accounting criteria require that the contractor's accounting system record all direct and indirect costs applicable to the contract. Contractors must be able to

summarize costs from the level that they are applied up through the WBS and functional organizational structure. Except for one, these criteria are essentially those required by the Defense Contract Audit Agency (DCAA) for all defense contractors. The one criterion not required by the DCAA deals with material costs, and requires most companies to add practices and procedures to comply with C/SCSC.

The analysis criteria establish the characteristics that contractors' systems must possess, and specify the type of data that should be derived from the contractors' systems to adequately measure and address performance. In essence, these criteria require a comparison of actual versus planned performance, calculation of variances, and analysis of variances. The study states that most well-managed companies do not have formal methods of determining earned value established.

The revisions and access to data criteria require the contractor to maintain a valid performance measurement baseline, and provide government access to internal data. Most well-managed companies do not have procedures to meet these criteria, however, compliance to them would not take much effort.

The validation of compliance to C/SCSC is usually completed after reviews by government teams. The teams usually consist of seven to fifteen people. These reviews require additional effort from both the contractor and government.

This study concludes that there are cost impacts associated with imposing C/SCSC, but it is impossible to quantify these costs. It is, however, possible to identify the major cost drivers and their sources. The major cost drivers are the implementation of

earned value, and the level of detail and rigid interpretation. The minor cost drivers are the terminology, material accountability, and change control.

This study recommends several ways of minimizing the cost drivers. First, the DoD must ensure knowledgeable and experienced C/SCSC team leaders and members are appointed. The team leaders and members must work with the contractor, specifically in the implementation process, to help the contractor fully understand the C/SCSC requirements. Also, the DoD must ensure that all members of the government review team are properly trained. Several courses are available to DoD employees which can provide adequate training.

Title: Major Acquisitions: Significant Changes Underway in DOD's Earned Value Management Process

Author:

Format: GAO Report

Date/Published: May 1997

Pages: 1-31

This report addresses the problems facing the Cost/Schedule Control System Criteria (C/SCSC) process. It also summarizes the progress resulting from DoD reforms and some challenges that DoD will face during the implementation and management of these changes. The evolution of earned value is given from the inception of C/SCSC through the current Industry Standard Guidelines for Earned Value Management Systems (EVMS).

As further testament to the value of earned value, the report highlights the fact that commercial firms are adopting the concept of earned value more and more. Although many of these new implementations of C/SCSC are being applied in a more streamlined manner than in the past, the basic concept of earned value is still very much alive and well. For example, United Defense Limited Partnership (a major defense contractor) has incorporated earned value into their entire management structure. Also, Lockheed-Martin Missiles and Space has announced it is adopting earned value for all its contracts. These include contracts with military or commercial customers.

Title: Cost/Schedule Control System Criteria: A lighthearted introduction for the non-believer

Author: Lee R. Lambert

Format: Article in AACE Transactions

Date/Published: 1988

Pages: D.11.1-D.11.5

The author generally endorses C/SCSC, but warns that in order for it to be successful, a few things must be present. First, there must be top management support for the implementation of a C/SCSC compliant system. Second, education and training will determine if the system is productively utilized or is just another management “toy”. The rest of the article describes how to set up an effective training program.

Several benefits of the C/SCSC approach are given including the ability to:

- provide information that will enable managers and contributors to take a more active role in defining and justifying their own roles.
- alert managers to potential problems in time to be proactive instead of reactive.
- allow a manager to clearly demonstrate timely technical accomplishments.
- provide the basis for significant improvement in internal and external communications.
- provide a powerful marketing tool for future technical projects and programs which require high management content.
- provide the basis for consistent, effective management system based training and education.

- provide a more definitive indication of the cost and schedule impact of technical problems.
- allow tremendous flexibility in its application.

Finally, the article ends by stating that a C/SCSC validated system can become one of the most meaningful, effective and efficient tools a technical professional has available, given that the users are informed and supportive.

Title: The Marginal Cost and Practicality of Cost/Schedule Control Systems Criteria Implementation

Author: Lampkin, Eric D.

Format: Comptroller Research Project

Date/Published: May 1992

Pages: 42

In May 1991, the Joint DoD/Industry Total Quality Management Team (JTQMT) examined and identified opportunities to improve the cost/schedule management process. The JTQMT gave 18 recommendations for streamlining the process, surprisingly, the cost issue was not the most dissatisfying driver against C/SCSC implementation. Although an almost unanimous agreement that the cost of C/SCSC implementation and cost performance reporting is of high importance, more than 90% of all interviewees (DoD and Industry) placed extremely high importance on the need for C/SCSC.

This research project plans to expand on the JTQMT report by focusing on the cost of C/SCSC. Specifically, the marginal cost and practicality of C/SCSC implementation will be examined (marginal C/SCSC cost is the cost above the normal operating costs of contractor cost/schedule management systems). The project assumes that the cost account manager's fixed salary will not fluctuate with the addition or subtraction of administrative tasks. Secondly, tremendous savings in both time and money can be realized with the technical advancements in the computer hardware and software industry. It is important to note that FAR 52.234-7001 states "When systems existing at the time of contract award do not comply with the criteria, adjustments

necessary to assure compliance will be effected at no change in contract price or fee.”

Although the FAR implies that there is no added cost to the Government, the contractor should, and does receive compensation for those things added because of C/SCSC. This compensation is negotiated prior to contract award.

In starting the project, the author notes that it is possible to quantify an individual contractor's cost for C/SCSC implementation, system maintenance, and use. However, there is no way to determine a quantified dollar value that can be applied to every government contractor. With the help of C/SCSC consultants, the following generic C/SCSC implementation process was designed to help break-out the costs:

Project System Implementation	Contractor Person-Days	Consultant Person- Days	Total Person- Days
Step 1 - Team organization and start up	40-60	0	40-60
Step 2 - System assessment	128-188	75-135	203-323
Step 3 - Subsystem development	275	60-120	180-300
Step 4 - System documentation	56-83	143	418
Step 5 - System implementation	130-200	56	112-139
Step 6 - System training	50-200	50-100	180-300
Step 7 - Compliance and classification assistance	89-189	20-40	70-240
Step 8 - Additional Support	240	38-58	127-247
TOTAL	1008-1435	382-432	1390-1967

To test the validity of this implementation process, an implementation process survey was designed for: 1) contractors to verify those activities applicable to their implementation process and those associated costs, 2) capturing those activities done solely to satisfy the C/SCSC, 3) identifying those activities that would be eliminated from day-to-day management if the C/SCSC were removed from the contract, and 4) splitting

the implementation process activities and their associated costs into recurring and non-recurring activities. Eighteen surveys were returned; eight from contractors, and ten from experienced AF personnel.

From the returned surveys, implementation processes were validated, and costs were divided into recurring, and non-recurring. The majority of contractors revealed that it was necessary to hire consultants at contract start-up to assist them in the implementation process. All of the respondents indicated that to satisfy the Government review process, they established subsystem flow diagrams with narratives, and that they had to expand their written procedures to describe how their systems complied with the criteria. Additionally, all contractors indicated that it was necessary to design or revise forms to help comply with the criteria. Most of the contractors indicated that it was necessary to purchase new hardware/software, citing the large volume of data requiring compilation, and timely reporting as the primary reasons. Although the survey identified those activities which were only done to satisfy the criteria, the majority of contractors stated that they would continue to maintain criteria compliant systems even if the criteria were removed from the contract. The general consensus is that changes in the contractor's workload, due to the removal of the criteria, would be insignificant. This conclusion justifies the contractor's position of giving nothing back to the Government for the removal of the criteria.

This project also studied the actual time from contract award to system validation. DoD FAR clause 52.234-7001 states that validation is to occur within 90 days of contract award. While this would be ideal, it is rarely the norm. The defense industry 15-man Ad

Hoc Committee recommends that validation within 180 days of contract award would reflect actual practice. The Arthur D. Little study estimated that validation process takes 12 months for a subsequent application review (SAR), and 18 months for a demonstration review. From the surveys, this project estimated that validation takes an average of 10.5 months to complete. This project did note that assigning the implementation process to high-level managers versus junior personnel was the most significant reason for shorter validation times.

Finally, this project cited other studies that estimated the percentage of the contract value that is associated with implementing C/SCSC. A private study by Humphreys & Associates projected a cost range of 0.5% to 4% of the total contract value. This estimate was further refined into recurring (SAR-type) activities, and non-recurring (DEMO-type) activities. Their study estimated the recurring costs to be from 0.5% to 1.5% of total contract value. The non-recurring costs were estimated as 1.5% to 2.5% of total contract value. The MITRE Corporation study for Electronic Systems Division stated that the C/SCSC implementation costs for software acquisition and development are 0.1% to 0.2% of the total contract value. A cost model from Decision Planning Corporation estimated implementation cost as 0.6% to 1% of the total contract value. A study by Major Kouts reported estimates from 0.5% to 5% of total contract value, with a mean of 3%. The DoD Inspector General reported that, based on his experience, 5% of the total contract value was a reasonable estimate for implementing and maintaining a criteria compliant system. The following table summarizes these results:

Study	Cost Range*	Basis	Recurring	Non-Recurring
MITRE	0.1 - 0.2%	Software Acq Model	N/A	N/A
SPARROW	0.6 - 1.0%	Cost Est. Model	N/A	N/A
KOUTS	0.5 - 5.0%	Industry Response	N/A	N/A
DoD IG	5.0%	DoD Response	N/A	N/A
HUMPHREYS	0.5% - 4.0%	Consultant Response	0.5% - 1.5%	2.5% - 4.0%
Avg Range	0.4% - 2.86%		0.4%	1.63%
Mean of Averages	1.69%		N/A	N/A

* Percent of Negotiated Total Contract Value

Title: Survey Relating to the Implementation of Cost/Schedule Control Systems Criteria
Within the Department of Defense and Industry - Phase I

Author: Arthur D. Little, Program Systems Management Company

Format: Report for the Assistant Secretary of Defense (Comptroller)

Date/Published: 5 December 1983

Pages: 216

This report was conducted in an effort to resolve two controversies surrounding C/SCSC: 1) do the costs of the criteria and associated reporting requirements outweigh their benefits?, and 2) concerns about the specifics of how these requirements have been implemented. The report was accomplished in two phases, the first being a mailed questionnaire, and the second, in-depth interviews with DoD and industry respondents. Four populations were surveyed: DoD program managers and business managers, and contractor program and business managers. **The most important finding of the survey was that the majority of respondents believe that C/SCSC benefits to themselves outweigh its costs.** However, the majorities ranged from 53% to 62% in the four populations.

Of important note is the manner in which the report investigated the question: do the benefits of C/SCSC outweigh its costs? This report notes that the primary difficulty in answering this question is determining the incremental cost between operation of a C/SCSC compliant system and the operation of a system the contractor would otherwise

use. Since information of the cost of the latter is not readily available, this report dealt with this question as a matter of respondent perceptions.

This report generated the following data from the specific question,
“Approximately how many man years per year of all categories of employees are spent on operating your C/SCSC-accepted system for this contract and analyzing its output?”
(This table represents the approximations provided by 114 contract business managers):

Cost of Operation of C/SCSC-Accepted System (Man-Years per Year)	Contractor Business Manager Responses
0 - 5	18%
6 - 10	28%
11 - 15	21%
16 - 20	9%
21 - 30	11%
31 or More	13%
TOTAL	100%

Outside of this qualitative data, the issue - do the benefits of C/SCSC outweigh the costs, was determined qualitatively.

This reports find four primary conclusions about the benefits vs. Costs of C/SCSC issue:

1. C/SCSC-accepted systems are considered to be effective in assisting to control cost and schedule performance.

2. CPRs and related contractor reports are considered to be accurate. CPRs are considered most useful for determining contract cost status.

3. C/SCSC benefits are considered to outweigh the costs. Nevertheless, most contractor program managers see a need for minor modifications to their systems. Many program managers agree.

4. Manpower costs for operating C/SCSC-compliant systems (not the cost of C/SCSC) is approximated as 10 man-years per year or less for nearly half of contracts. Manpower costs appears to vary directly with contract value.

Title: Survey Relating to the Implementation of Cost/Schedule Control Systems Criteria Within the Department of Defense and Industry - Phase II

Author: Arthur D. Little, Program Systems Management Company

Format: Report for the Assistant Secretary of Defense (Comptroller)

Date/Published: 15 August 1984

Pages: 61

Please reference the abstract on Phase I prior to reading this. Phase II of the Arthur D. Little study consisted of personal interviews in an attempt to gather more detailed information on the issues and problems suggested in the Phase I results. Four contractor organizations and four DOD program offices within each of the three military departments were selected for in-depth interviews. In the cost and benefits of C/SCSC portion of the Phase II study, the objective was to identify the minor modifications that program managers perceived to be needed.

These interviews lead to several suggested modifications to the current C/SCSC. The most prevalent modification, suggested by industry, was the deletion of the variance analysis at the cost account level, as well as other documented analysis. Another suggestion was the need to raise the level of the work breakdown structure (WBS) at which cost accounts were established. A final industry suggestion was the deletion of inappropriate rules related to replanning. The study makes an important note: the government need for information is not always taken into account by the contractors. The study concluded the cost and benefit portion by explaining that the excessive level of detail problems are due to the inadequate skills and insights of some of the governmental

overseers. These overseers include both government personnel on the demonstration and subsequent application review teams, and those government personnel involved with negotiating WBSs, reporting levels, and thresholds for analysis.

Overall, Phase II concluded that, most importantly, C/SCSC is a valid concept and approach to controlling contract performance. Additionally, the study presented ten recommendations for improvement which are listed below:

1. A brief White Paper discussing the purpose and value of C/SCSC
2. A certification process for practitioners
3. A centrally controlled manpower pool should be established for technical support and augmentation of C/SCSC review and surveillance teams.
4. A jointly manned C/SCSC group should be organized.
5. Use of incentives.
6. Initial high-level government contacts with senior contractor official for C/SCSC reviews.
7. Schedule event discussion on CPR problem analysis format.
8. Clarification of terminology in DOD guidance.
9. Separate submittal of CPR formats (i.e. do not wait for all formats to be completed, send out the formats as they are individually finished).
10. Data-nets for CPRs (automated transmittal of CPR data).

Title: Cost/Schedule Systems Compendium

Author: National Security Industrial Association

Format: Compendium

Date/Published: Washington, DC: October 1980

This compendium summarizes the responses from 74 companies resulting from a questionnaire developed by the National Security Industrial Association (NSIA). The purpose of this project was to provide industry with a data base to aid contractors recently exposed to Performance Measurement System Requirements as well as contractors with previously accepted systems. Another objective of this projects was to provide data from which future improvements could be made in requirements and implementation practices.

The responses to several of the questions lend evidence to the merit of earned value. For instance, when asked what levels of senior management use their cost performance reports (with their earned value measurements) for status information, the respondents indicated the report is utilized by: 99% of contract program managers; 57% of functional branch managers; 55% of finance controllers; 50% of company Vice Presidents; as well as very small portion of corporate vice presidents and other managers.

When asked what measurements are visible in the labor work package system besides budget, the respondents indicated that "earned value credited" is used more than any other measurement listed including "underlying standards/goals" of the organization.

In response to which management level performs the analysis and makes the routine estimate update for the revised EAC, respondents indicated the cost account

manager function was most involved with these tasks. However, there was strong indications of multiple participation by various levels of management.

When asked to evaluate the utility of their system procedures to satisfy both internal operating needs as opposed to the evaluation needs of government reviewers, the results indicated that 73% of the respondents believe that C/SCSC procedures are aligned to satisfy operating needs. Further, 62% indicated C/SCSC procedures are aligned to satisfy government review visibility.

Another part of the survey asked which C/SCSC concepts have been applied to other contracts or commercial applications where C/SCSC was not a contractual requirement. Although responses indicated very few contractors utilized the criteria fully in these situations, various concepts were used quite heavily. For instance, Budgeted Cost of Work Performed (BCWP) was utilized by over 70% and Estimate At Completion (EAC) and reporting methods by over 80% of respondents.

Title: Summary Level Variance Analysis

Author: Pakiz, John

Format: White Paper

Date/Published: 26 FEB 93

Pages: 7

This white paper reflects the National Security Industrial Association (NSIA) initiative to officially pursue the 1992 C/SCSC National Workshop recommendations. The May 1991 Joint Government and Industry Report for Program Management on Cost/Schedule Management Process detailed the most significant C/SCSC improvements would be in the area of variance analysis. Both Government and industry cited excessively detailed requirements, repetitive narratives, and voluminous paperwork as reasons for dissatisfaction. The June 1992 DoD Team Chief meeting verified that variance analysis reports, written at the cost account level, a feature of most contractor systems, are not required by policy. These cost account variance reports are a product of unwritten implementation rules. Significant costs can be avoided , and system effectiveness improved by assuring that variance analysis reporting is a function of how the contractor manages the work. Summary level variance analysis includes one or more cost accounts, while still identifying the problems, impacts, and corrective actions for those cost accounts with significant cost/schedule variances. Achievement of summary level variance analysis must be done on a case-by-case basis by first understanding the

contractor's management process, and then determining if changing the system description complies with C/SCSC.

Three contractor's assessments of the savings associated with summary level variance analysis are:

1. TRW reports a cost effective approach to variance analysis resulting in reduced monthly reporting time, reduced steps in the variance analysis cycle, and elimination of redundant reporting.
2. IBM Federal systems cites a 45% reduction in variance analysis documents and an order of magnitude reduction in the volume of data to be analyzed.
3. McDonnell Douglas Aerospace discovered that fewer reports and more efficient and shortened analysis cycles were the result of the switch to summary level variance analysis. In their RDT&E contract test case, variance analysis reports were reduced from 100 to 15. In their production contract test case, variance analysis reports were reduced from 70 to 6. A 20%-40% reduction in cost and cycle time was also reported.

In conclusion, this white paper drafts an opportunity to reduce the cost of C/SCSC, while the compliance of the criteria is still fully maintained.

Title: What's the value of Earned Value?

Author: Nancy Singletary

Journal: PM Network

Date: December 1996

Pages: 28-29

This author talks about how earned value has evolved over the years. The predecessor of earned value, Cost/Schedule Control Systems Criteria (C/SCSC), not only has survived over the years but seems stronger and more useful now than ever. Earned value is no longer just a method for meeting (C/SCSC) standards for the DOD. The usefulness of the earned value concept is reflected by its increasing use in commercial industries, public and private sectors, manufacturing, financial institutions, pharmaceuticals, and other industries. The increased utility of earned value is due in part to advances in computers, software packages and documentation to support the earned value methodology. Earned value is a powerful management tool that is essential for risky or high-dollar projects. It also gives us the ability to compare the progress of dissimilar projects.

Title: Potential Benefits and Problems Related to Contractor Compliance with DoDI

7000.2 (C/SCSC)

Author: Whittenberg, Ira O.

Format: Article in National Contract Management Journal

Date/Published: Fall 1972

Pages: 73-80

Despite the title of this article, the author focuses more heavily on the problems related to contractor compliance with C/SCSC. However, some of the benefits related to compliance with C/SCSC are also listed.

First, he states that full implementation of the objectives of C/SCSC, with reasonable deviations allowed when applicable, will result in improved contractor management systems, better cost visibility and will probably help reduce overruns on future programs.

Next, through complying with the C/SCSC requirements, a contractor may finally incorporate long needed improvements in their system that they had resisted implementing before. Further, the review team can be a major benefit to the contractor by suggesting good features that they have experienced on other systems in the defense industry.

It should be noted that Lieutenant Colonel Robert R. Kemps, in a written response to the editor of the National Contract Management Journal rebukes most of Whittenberg's criticisms given in this article.

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13. ABSTRACT (<i>Maximum 200 Words</i>) In December 1996, the Cost/Schedule Control Systems Criteria (C/SCSC) was officially replaced by the Earned Value Management Systems (EVMS) criteria. The switch to EVMS, coupled with current acquisition reform changes, have left many wondering what the effects of these changes will be. This thesis defines the costs and benefits of the old C/SCSC, and then compares them. Additionally, this thesis discusses the changes accompanying the switch to EVMS and the effect on the costs and benefits. The marginal costs of C/SCSC are defined as the difference between the costs of a C/SCSC-compliant system and a contractors 'normal' management control system. The marginal system compliance costs are 334 - 481 person days, while the marginal operating costs are 50% of the C/SCSC-compliant operating costs. Fourteen benefits of C/SCSC are detailed in this thesis. The most important benefit discovered was the data reliability that comes with a criteria-compliant management control system. The main difference between C/SCSC and EVMS is the system certification process. Under C/SCSC, DoD teams would have to certify a contractor's system. Under EVMS, contractors have the ability to self-certify their system (with final government approval). Cost savings may result through self-certification without reductions in the benefits.				
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